According to New National Curriculum 2022-23
Federal Board SLO BASED Examination 2026

COLLEGE
Physics
PBA 11&12

PRACTICAL BASED ASSESSMENT
HSSC (COMPOSITE)

WORKBOOK

Section A: (6 x 3 = 18 Marks)

Section B: (4 x 3 = 12 Marks)

Total Marks: (18 + 12 = 30)

50+ PBA Self Assessment Tests on Actual Exam Pattern of FBISE

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COLLEGE
PUBLICATIONS

CONTENTS

SECTION A	60% of practical marks	18 Marks

Part-1 (SLO)

[SLO: P-11-A-05] [SLO: P-11-A-06] [SLO: P-12-N-06] [SLO: P-11-A-05] [SLO: P-11-A-06]
[SLO: P-11-B-42] [SLO:P-11-D-12] [SLO:P-11-D-10] [SLO: P-11-E-23] [SLO: P-11-D-03]
[SLO: P-12-E-06] [SLO:P-12-E-25] [SLO: P-12-E-08]

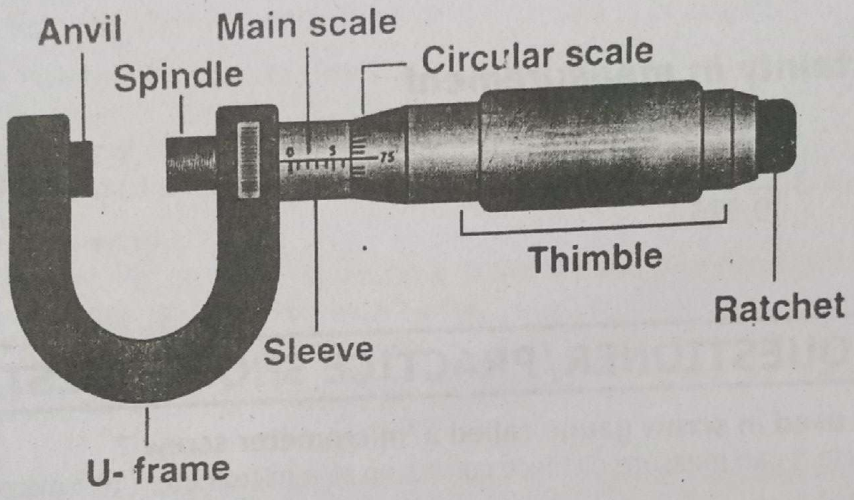
Sr.#	PRACTICALS		PAGE#
1	**Measure the volume of a small spherical object using screw gauge and calculate the uncertainty in the result.**		2
	PBA Sample paper – 1, 2 & 3 with solutions	(Each Test : 06 Marks)	4
2	**Determine the radius of curvature of convex lens using a spherometer and calculate uncertainty in the result.**		9
	PBA Sample paper – 1, 2 & 3 with solutions	(Each Test : 06 Marks)	13
3	**Investigate the fall of spherical steel ball through a viscous medium and determine Coefficient of viscosity of the fluid**		18
	PBA Sample paper – 1& 2 with solutions	(Each Test : 06 Marks)	21
4	**Study stationary waves using Melde's apparatus and calculate the frequency of AC source.**		25
	PBA Sample paper – 1, 2 & 3 with solutions	(Each Test : 06 Marks)	27
5	**Determine the wavelength of sound in air using stationary waves and to calculate the speed of sound at 0°C using resonance tube.**		32
	PBA Sample paper – 1, 2 & 3 with solutions	(Each Test : 06 Marks)	35
6	**Compare the emf of cells using potentiometer.**		39
	PBA Sample paper – 1, 2 with solutions	(Each Test : 06 Marks)	41
7	**Determine the time period, frequency and angular frequency of simple pendulum by varying its length.**		44
	PBA Sample paper – 1, 2 & 3 with solutions	(Each Test : 06 Marks)	47
8	**Determine the relation between current and capacitance for different combinations of capacitors in AC circuits.**		53
	PBA Sample paper – 1, 2 with solutions	(Each Test : 06 Marks)	57
9	**Study the charging and discharging of a capacitor through a resistor and calculate the time constant.**		61
	PBA Sample paper – 1, 2 & 3 with solutions	(Each Test : 06 Marks)	64
	MODEL PAPERS	**SECTION-A MARKS 18**	
	PBA TEST with Solution	(Each Test: 18 Marks)	71

PRACTICAL 1

MEASURE THE DIAMETERS OF A FEW BALL BEARING OF DIFFERENT SIZES USING SCREW GAUGE AND ESTIMATE THEIR VOLUMES. MENTION THE UNCERTAINTY IN EACH RESULT.

pparatus

crew gauge, ball bearings, graph paper



Procedures

- Find zero error if any and then fix the metallic wire between two studs.
- Firstly note the main scale reading and then read circular scale reading and multiply it with L.C to get fractional reading.
- Now add fractional reading and main scale reading and apply zero error correction if any to get corrected diameter.
- Find radius of wire/sphere by using formula $r = \frac{D}{2}$
- Calculate area of cross section of a wire by using formula $A = \pi r^2$
- Calculate volume of sphere by using formula $V = \frac{4}{3}\pi r^3$

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Observations

L.C. = 0.01 mm
Z.E. = Nil mm

No. of obs.	Main scale reading M(mm)	Circular scale Reading 'n'	Fractional reading V= n x L.C.	Observed Reading R=M+C(mm)	Corrected Reading R + Z.C	Mean (mm)
1	9.4	47	0.47	0.47	0.47	9.973
2	9.5	48	0.48	0.48	0.48	
3	9.5	47	0.47	0.47	0.47	

Mean diameter = d = 9.973 mm

Radius = $r = \frac{d}{2} = 4.9865$ mm

Value of volume:

Volume of ball bearings = $\frac{4}{3}\pi r^3 = 519.10\ \text{mm}^3$

Percentage uncertainty in measurement

$$\frac{\Delta V}{V}\times 100\% = 3\frac{\Delta D}{D}\times 100\% = 3\left(\frac{0.01}{9.973}\right)\times 100\% = 0.3\%$$

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

1. Why is the screw used in screw gauge called a 'micrometer screw'?
Ans: It is so called because it can measure distance correct up to a micrometer (10^{-6} meter).

2. Why is a screw gauge so named?
Ans: Diameters of wires are governed by some standard numbers called standard wire gauge (S.W.G.). As the instrument measures these diameters, it is named screw gauge.

3. What is the principle of a screw gauge?
Ans: The principle is that when an ideal screw moves in a fixed nut, the translatory motion of the screw is proportional to the rotation given to the screw .

4. What are the various types of motions possessed by a screw?
Ans: The screw has two types of motions: (i) axis has linear motion, (ii) surface has circular motion.

5. What is a ratchet? Explain its utility.
Ans: Ratchet is an arrangement inside the milled head (R) at the end of the screw. It prevents the screw from undue pressure.

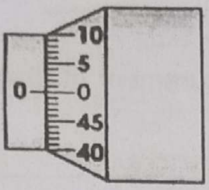
6. Define pitch of the screw gauge.
Ans: The pitch is the distance moved by the screw in one complete rotation. It is equal to the distance (measured along the axis) between the consecutive threads of the screw.

7. What is least count of a screw gauge?
Ans: It is the distance moved by the screw when it is rotated by one circular scale division. It is given by

$$\text{Least Count} = \frac{\text{Pitch}}{\text{No. of Divisions on circular Scale}} = \frac{1\text{mm}}{100} = 0.01\,\text{mm}$$

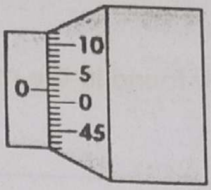
8. **What is zero error of screw gauge?**

Ans: When faces A and B of screw gauge come in contact and zero of circular scale does not come on reference line, the screw gauge has an error. This error is called zero error.



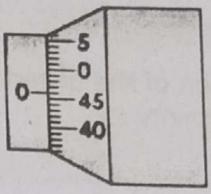
(a)

No zero error



(b)

Positive zero error



(c)

Negative zero error

9. **When is the zero error positive and when negative in a screw gauge?**

Ans: If on bringing the anvil and spindle of micrometer screw gauge together, the zero mark of the circular scale is below the main scale line, then the zero error is said to be positive.

If on bringing the anvil and spindle of micrometer screw gauge together, the zero mark of the circular scale is above the main scale line, then the zero error is said to be negative.

10. **What are the reasons for a zero error?**

Ans: The reasons for zero error are:

(i) Wear and tear of the screw

(ii) The defect in manufacturing.

11. **What is back-lash error?**

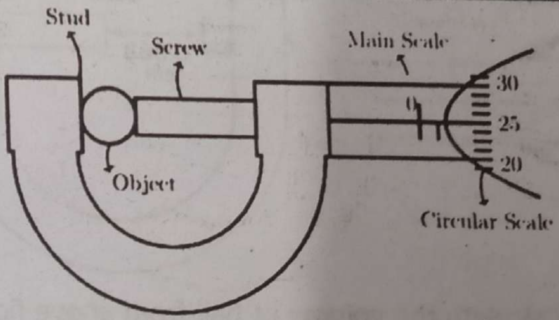
Ans: Due to wear and tear, the screw becomes loose in the nut and may not move forward when turned in the nut. Error due to this is called a back-lash error.

12. **How can the back-lash error be avoided?**

Ans: It can be avoided by exerting a slight lateral pressure on the screw and by turning it always in the same direction.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

Q. A screw gauge with a 0.5 mm pitch and a circular scale with 50 divisions is used to measure the diameter of a Aluminum sphere. Before measuring, it is found that when two jaws of the screw gauge are brought together, the 45th division coincides with the main scale and the zero of the main scale is barely visible.



(i) Complete observed reading columns (1)

No. of obs.	Main scale reading M(mm)	Circular scale Reading 'n'	Fractional reading V= n x L.C.	Observed Reading D=M+C(mm)	Corrected Reading D ± Z.C
1	0.5	25			

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(ii) What is volume of sphere and calculate the percentage uncertainty in measurement? (2)

(iii) Suggest what may be reason of the uncertainty found in the measurement of diameter of sphere and how we reduce such uncertainty (1)

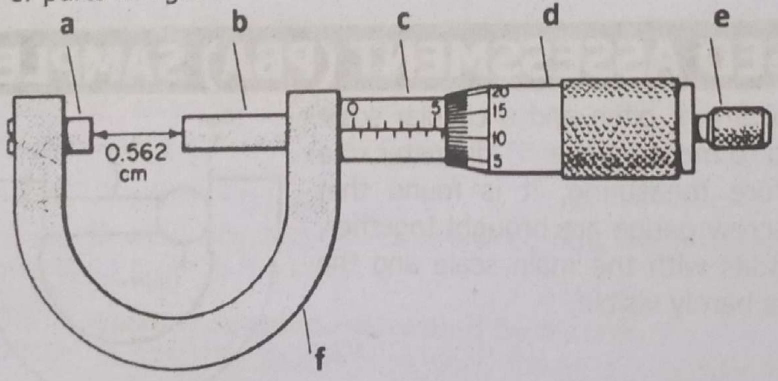
(iv) What is back-lash error? and how can the back-lash error be avoided? (2)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

Q. The student uses the micrometer screw gauge (units: cm) to determine volume of a ball bearing

(i) A student checks that there is no zero error on this micrometer. Explain what is meant by a zero error on a micrometer. (1)

(ii) Labeled the names of parts in figure? (2)

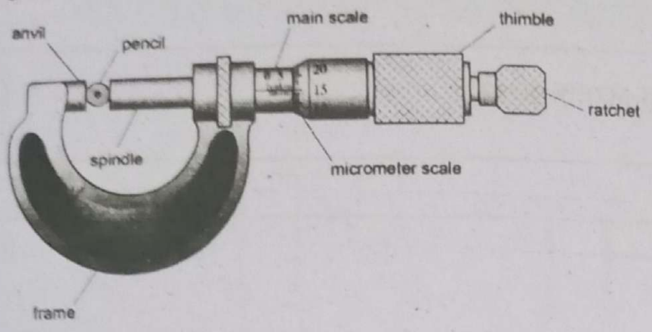


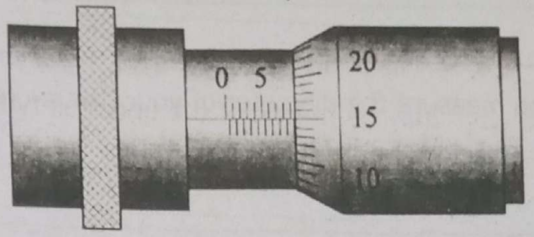
(iii) Calculate the volume of ball from above figure? (2)

(iv) Mention the uncertainty in result using Screw Gauge experiment. (1)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 3

Figure shows a micrometer screw gauge used to measure the diameter of a pencil


anvil
pencil
main scale
thimble
ratchet
spindle
micrometer scale
frame



i) State the main scale reading on the micrometer?

Reading = ______________________ unit = ______________________ (2)

From the circular scale reading on the micrometer, find fractional reading?

Reading = ______________________

(ii) The micrometer has a zero error. (1)

Describe how to determine an accurate measurement for the diameter of the pencil using this micrometer.

____

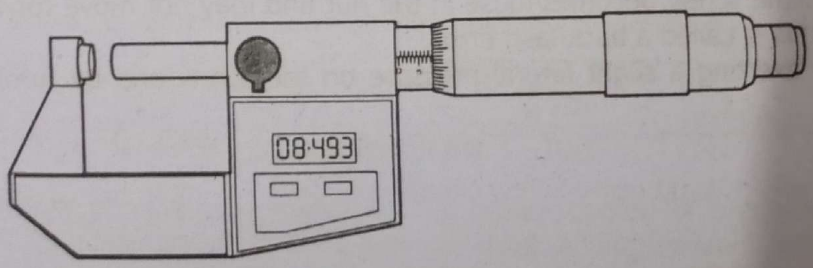
____

(iii) If the pitch of the micrometer screw gauge screw is 0.1 mm and its circular scale is divided into 100 equal parts. Find the least count of the micrometer screw gauge. (1)

____

____

(iv) Some modern micrometers are digital available in market.



Suggest one advantage of a digital micrometer. (1)

(v) Can you measure the diameter of your hair by your screw gauge? (1)

Solution: Practical Based Assessment (PBA) Sample Paper- 1

(i)

No. of obs.	Main scale reading M(mm)	Circular scale Reading 'n'	Fractional reading V= n x L.C.	Observed Reading D=M+C(mm)	Corrected Reading D ± Z.C
1	0.5	25	(25 x 0.01 mm)=0.25mm	0.5 mm + (25 x 0.01 mm) = 0.8 mm	0.8mm+(45 x 0.01mm) =1.2mm

Diameter = d = 1.2 mm

Radius = $r = \frac{d}{2} = 0.6$ mm

(ii) Value of volume:

Volume of ball bearings = $\frac{4}{3}\pi r^3 = 0.904\ \text{mm}^3$

Percentage uncertainty in measurement

$$\frac{\Delta V}{V}\times 100\% = 3\frac{\Delta D}{D}\times 100\% = 3\left(\frac{0.01}{1.2}\right)\times 100\% = 2.5\%$$

(iii) The uncertainty in the measurement of a sphere's diameter can arise from various factors. Diameter uncertainty stems from instrument limits, operator technique, and surface imperfections. Such uncertainty may be reduced by taking multiple readings and taking average value.

(iv)

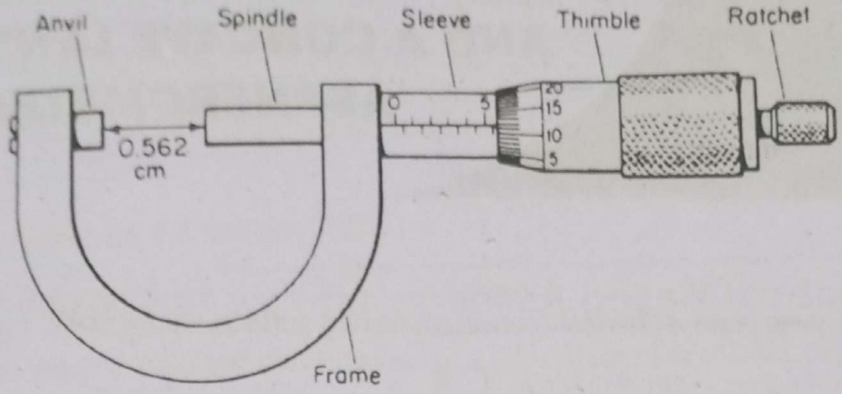
(v) Due to wear and tear, the screw becomes loose in the nut and may not move forward when turned in the nut. Error due to this is called a back-lash error.

It can be avoided by exerting a slight lateral pressure on the screw and by turning it always in the same direction.

Solution: Practical Based Assessment (PBA) Sample Paper- 2

(i) If the reading on a micrometer is not zero when it is completely closed (with out an object), then the reading shown it is known as the zero error on micrometer

(ii)



(iii) D=M+ V= M+[n x L.C]=0.55cm+[12x0.001cm]=0.562cm

$$r = \frac{d}{2} = \frac{0.562cm}{2} = 0.281\,cm$$

$$V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi(0.281)^3 = 0.093\,cm^3$$

(iv) The uncertainty in a screw gauge result depends on two factors:
Least count: This is the smallest difference the instrument can measure, typically 0.01 mm or 0.001 mm. It represents the minimum possible uncertainty in your result.
Random errors: These are small, unpredictable variations in your readings due to factors like temperature, vibration, or parallax error. They're difficult to quantify but can be minimized by taking multiple readings and averaging them.

Solution: Practical Based Assessment (PBA) Sample Paper- 3

(i) 9.5 mm
15 x L.C =15 x0.02 mm=0.30 mm

(ii) Let Close jaws and check line alignment to find positive or negative zero error.
Clamp pencil gently, tighten till slight resistance.
Read main scale + (circular line x least count) for diameter.
Incase Positive error: Subtract error from final reading.
Incase Negative error: Add error to final reading.

(iii) $$\text{Least Count} = \frac{\text{Pitch}}{\text{No. of Divisions on circular Scale}} = \frac{0.1\text{mm}}{100} = 0.0001\,\text{mm}$$

(iv) Digital micrometers can typically measure to a higher degree of precision, often resolving readings down to 0.001 mm compared to 0.01 mm on most analog models. This significantly reduces the margin of error, especially for critical measurements.

(v) No, we cannot measure the diameter of our hair by this screw gauge because the diameter of hair is less than the least count of screw gauge.

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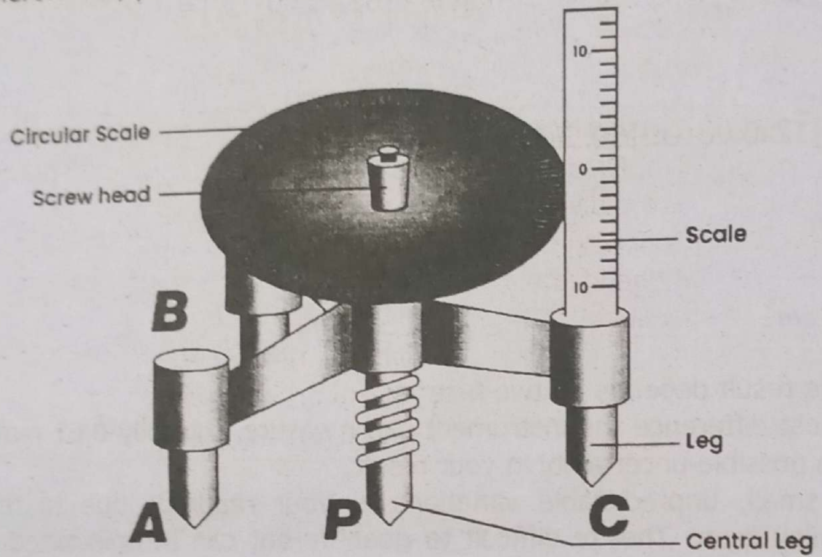
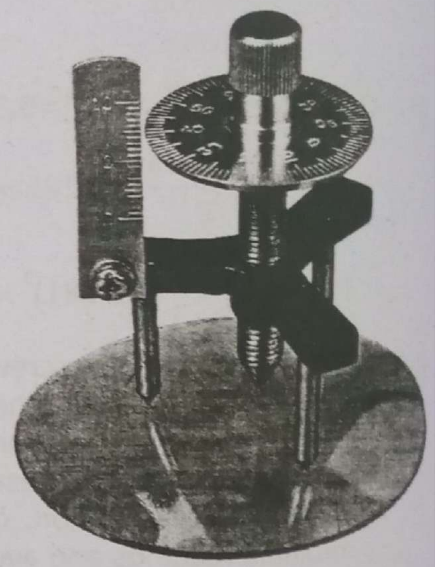
PRACTICAL 2

DETERMINE THE RADIUS OF CURVATURE OF CONVEX LENS AND A CONCAVE LENS USING ASPHEROMETER.

Apparatus

Spherometer, plane glass plate, spherical (convex/concave) surface, metre scale, etc





Procedures

1. First, press the spherometer gently on a piece of paper to mark the positions of the three legs. Label t
   marks as A, B, and C.
2. Next, connect the points A, B, and C to form a triangle and measure the distances between these poin
3. Find the mean distance between points AB, BC, and CA.
4. Determine the value of the pitch, which is the vertical scale division.
5. Record the values of the pitch and least count of the spherometer.
6. Lift the screw upwards sufficiently.
7. Now, place the spherometer on the spherical convex surface, ensuring all three legs are resting on it.
8. Gently turn the screw downwards until it makes contact with the convex surface.
9. Take a reading from the circular scale that aligns with the vertical scale. Let's call this value 'a'.
10. Remove the spherometer from the convex surface and place it on the plane mirror.
11. Count the number of rotations the disc makes as it moves downwards. Let's call this value 'n_1'.
12. Continue rotating the disc until the screw tip touches the plane surface of the mirror.
13. Take a reading from the circular scale that aligns with the vertical scale. Let's call this value 'b'.
14. Calculate the number of circular scale divisions from the last incomplete rotation.
15. Repeat steps 6 to 14 three times and record your observations.

Observation:

(1) For the determination of least count of spherometer-

Number of complete rotations given to screw $= 1$

Distance moved by the disc at the main scale $= 1mm$

Hence pitch of the screw x

$$= \frac{\text{distance moved by the disc at the main scale}}{\text{Number of complete rotation given to screw}}$$

$$= \frac{1mm}{1} = mm = 0.1cm$$

Number of division on the disc $n = 100$

Least count of spherometer $= \frac{x}{n} = \frac{0.1cm}{100} = 0.001cm$

Spherometer reading on plane glass plate $= M + C = 0.3\,cm + [62 \times 0.001\,cm] = 0.362cm$

(2) On convex spherical surface:

S.N	Main scale reading a (in cm)	Circular scale reading b (in cm)		Total reading $= a + b$ (in cm)
		No. Of circular scale division touching the edge of the main scale	No. Of division x least count (in cm)	
1.	0.3	94	$94 \times 0.001 = 0.094$	0.394
2.	0.3	94	$94 \times 0.001 = 0.094$	0.394
3.	0.3	93	$93 \times 0.001 = 0.093$	0.393

Mean reading $= \frac{0.394 + 0.394 + 0.393}{3} = \frac{1.181}{3} = 0.3937cm \approx 0.394cm$

(3) For the determination of distance l between the legs of a spherometer

$$AB = 2.6cm, BC = 2.6cm, CA = 2.6cm$$

$$Mean\, l = \frac{2.6 + 2.6 + 2.6}{3} = 2.6cm$$

Calculation

Height h of the spherical surface = Mean reading on spherical surface- Mean reading on plane glass plate

$$= 0.394cm - 0.362cm = 0.032cm$$

Radius of curvature of spherical surface

$$R = \frac{l^2}{6h} + \frac{h}{2} = \frac{(2.6)^2}{6 \times 0.032} + \frac{0.032}{2} = 35.208 + 0.016 = 35.224cm$$

Result:

Radius of curvature of the given spherical surface $= 35.224cm$

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POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

1. Why is the spherometer so named?

Ans. It is so called because it is used to measure the radius of curvature of a spherical surface.

2. What is the principle of a spherometer?

Ans. This works on the principle of a screw. When a screw moves in a nut, the translatory motion of the screw is proportional to the rotation given to the screw.

3. What do you mean by the pitch of the spherometer?

Ans. The distance moved forward or backward by the screw on given one complete rotation, is known as the pitch. It is equal to the distance between the two consecutive threads on the screw.

$$pitch = \frac{distance\ moved\ for\ a\ given\ rotation}{Number\ of\ rotations\ given}$$

4. What do you mean by the least count of the spherometer?

Ans. The distance moved forward or backward by the disc when it is rotated by one circular scale divisio

$$least\ count = \frac{pitch\ of\ spherometer\ screw}{numer\ of\ division\ on\ circular\ scale}$$

5. What is the backlash error? How can it be avoided?

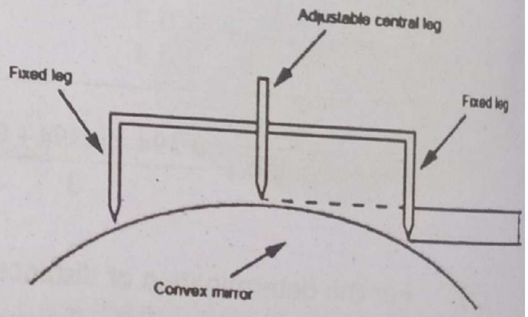
Ans. Backlash error: The slack in a worn screw-nut pair that makes the screw slip (and the head-sc reading change) when rotation is reversed while the main-scale reading stays fixed.
How to avoid it: Always approach the final setting by rotating the screw in the same direction; if y must reverse, overshoot slightly and come back to eliminate the slack.

6. Do you calculate zero error in your spherometer experiment? If not, then how can you remove it?

Ans. No, a spherometer does not have a zero error because the result obtained is by taking the difference between the final and initial reading.

Explanation:

Let the spherometer is placed on a plane glass plate and reading is taken by assuming zero at its lowest mark. The spherometer is then placed on the spherical surface and again reading is taken by assuming zero at the lowest mark. The difference between these readings gives the height of the spherical surface.



7. What are the characteristics of an ideal spherometer?

Ans. (i) The threads of the screw must be throughout narrow and uniform.
(ii) There must be no backlash error.

8. What is meant by the radius of curvature of a spherical surface?

Ans. Each spherical surface is a part of a sphere whose radius is called the radius of curvature of th spherical surface.

9. What is the relation between the curvature and radius of curvature of a spherical surface?

Ans. The reciprocal of curvature of the spherical surface is called the radius of curvature of that spherica surface.

$$curvature = \frac{1}{radius\ of\ curvature}$$

10. What is the radius of curvature and curvature of a plane surface?

Ans. The radius of curvature of a plane surface is infinity and curvature is zero.

11. State the formula for radius of curvature in your experiment?

$$R = \frac{\ell^2}{6h} + \frac{h}{2}$$

12. Which of the quantity is to be measured with accuracy: ℓ or h and why?

Ans. h, since it is a small quantity.

13. Can you measure the radius of curvature of earth with a spherometer?

Ans. No, since the radius of curvature of earth is so large that the value of h will be nearly zero.

14. State the greatest and the smallest sphere whose radius of curvature can be measured with your spherometer?

Ans. The sphere for which the value of h will be equal to least count of the spherometer will be greatest sphere and the sphere, that can be kept among the three external legs of spherometer will be smallest sphere.

15. There are three legs in a spherometer, why?

Ans. Because any plane can be described by at least three points, which are not in a straight line

16. Is equal distance necessary among the three legs?

Ans. Yes, otherwise formula $R = \frac{\ell^2}{6h} + \frac{h}{2}$ will not be applicable

17. Write the applications of spherometer in physics lab?

Ans. It is particularly valuable in determining the focal length of lenses and the shape of concave or convex mirrors.

18. What are Uncertainties involved in experiment?

Ans: Several factors can influence the accuracy of measurements obtained with a spherometer.

- Spherical tips at the end of the legs must be carefully machined and have a smooth, curved surface to ensure accurate contact with the surface being measured.
- Any movement or instability during measurements can lead to inaccurate results.

19. What are Sources of error in spherometer measurements

Ans. There are several potential sources of error in spherometer measurements.

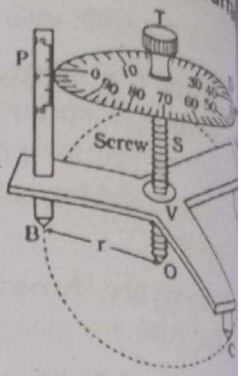
- Backlash Error: Play between the screw and nut causes a lag when the rotation direction is changed.
- Parallax Error: Incorrect scale reading due to the eye not being perpendicular to the scale.
- Poor Contact: Uneven or dirty tips, or an unclean surface, prevent proper contact with the sphere.

20. What are the Limitations of using a spherometer

- They are primarily designed for measuring spherical surfaces and may not be suitable for measuring non-spherical or irregular surfaces.
- Spherometers may have a limited measurement range depending on their design, requiring different instruments for large or small radii of curvature.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPE

Q. Figure shows a spherometer used to measure radius of curvature of the convex surf



(i) If the pitch of a spherometer is 1 mm and there are 100 divisions on its disc. What is the least count of instrument? (1)

(ii) If spherometer rests on plane glass plate, mean reading of height is 2.42mm. then spherome on a convex surface, If the distance between its outer legs is 4 cm, find the radius of curvatu convex surface?

S.N	Main scale reading	Circular scale reading b (in cm)		Total reading $= a + b$ (in cm
		No. Of circular scale division touching the edge of the main scale	No. Of division x least count (in cm)	
1	2mm	63	63 x 0.01 mm	

(a) Complete total reading column?
(b) Calculate height of the spherical surface?
(c) What is radius of curvature of spherical surface?

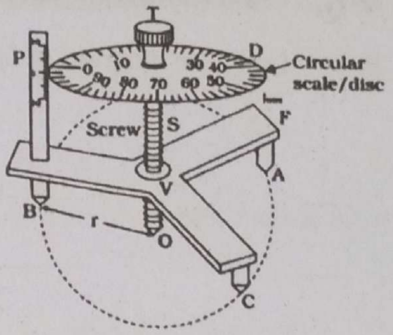
(iii) What is the effect of changing the number of circular divisions from 100 to 50 on least count?

(iv) Out of two curved surfaces for which the value of h is 0.152mm and 0.205 mm respectively, wh surface has the larger radius of curvature using spherometer?

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

Q. Students use a spherometer to measure the radius of curvature of a convex lens.

i. If the pitch of the spherometer is 0.5 mm and there are 50 divisions on its disc, what is its least count? (01)



ii. This spherometer gives a mean height of 2 mm when placed on a plane glass plate. Now it is placed on the convex surface of the lens. The distance between any two outer legs is 3 cm.

a. Copy and complete the table. (02)

Main scale reading a	Circular scale reading b (divisions)	Circular scale division x least count (in cm)	Total reading = a + b (in cm)
2 mm	30		

b. Calculate the height of the spherical surface. (01)

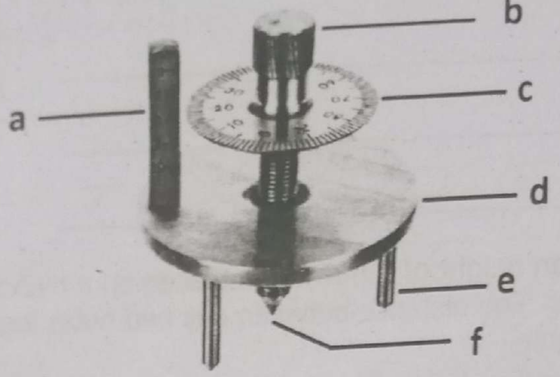
c. Calculate the side length of the equilateral triangle formed by the legs of the spherometer and use it to find the radius of curvature. (01)

iii. How would you differentiate between convex and concave surfaces using a spherometer? (01)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER

Q. Figure shows a Spherometer used to measure radius of curvature of the convex surfa

(i) Label the diagram of Spherometer



(ii) If Spherometer rests on plane glass plate, mean reading of height is 1.40 mm. then Spheromete on a convex surface, If the distance between its outer legs is 3 cm, find the radius of curvature o convex surface?

S.N	Main scale reading	Circular scale reading b (in cm)		Total reading $= a + b$ (in cm)
		No. Of circular scale division touching the edge of the main scale	No. Of division x least count (in cm)	
1	2mm	75	75 x 0.01 mm	

(a) Complete total reading column?
(b) Calculate height of the spherical surface?
(c) What is radius of curvature of spherical surface?

(iii) *If the true value of radius of curvature is 12.34 cm and measured value is 12.06cm then find the percentage uncertainty in the measurement of radius of curvature of lens*

Solution: Practical Based Assessment (PBA) Sample Paper- 1

i)

$$least\ count = \frac{pitch\ of\ spherometer\ screw}{numer\ of\ division\ on\ circular\ scale} = \frac{1mm}{100} = 0.01mm$$

ii) Add the main scale reading: 2.0 mm.
Add the circular reading: 63th division on the circular coinciding with the main scale line means 63 x least count (usually 0.01 mm).

(a) Total reading : 2.0 mm + (63 x 0.01 mm) = 2.63 mm.

(b) Height h of the spherical surface =
Mean reading on spherical surface- Mean reading on plane glass plate

$$h = 2.63mm - 2.42mm = 0.21mm = 0.021cm$$

(c) Radius of curvature of spherical surface

$$R = \frac{l^2}{6h} + \frac{h}{2} = \frac{(4)^2}{6 \times 0.021} + \frac{0.021}{2} = 126.99\,mm$$

ii) Changing the number of circular divisions from 100 to 50 on a spherometer increases the least count, making the instrument less sensitive to small changes in height.

Explanation:

The least count of a spherometer is the smallest change in height that can be measured with the instrument.

In this case, the pitch of the screw remains the same, but the number of divisions is reduced from 100 to 50. This means we're essentially "stretching" the same distance (pitch) over fewer divisions, resulting in a larger jump in height for each division. it would be less accurate for precise measurements compared to one with 100 divisions.

v) First surface has more radius of curvature for which h = 0.152mm.
Since the value of ℓ is the same for both surfaces, it cancels out during comparison. We are left with comparing the denominators, which are inversely proportional to the radius of curvature (larger denominator means smaller radius).

$$R = \frac{l^2}{6h} + \frac{h}{2}$$

The surface with the smaller denominator in its equation will have the larger radius of curvature.

Solution: Practical Based Assessment (PBA) Sample Paper- 2

$$Least\ count = \frac{0.5mm}{50} = 0.01mm = 0.001cm$$

(a)

Main scale reading a	Circular scale reading b (divisions)	Circular scale division x least count (in cm)	Total reading = a + b (in cm)
2 mm	30	30x0.001cm=0.03	0.2+0.03=0.23

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(b) Height h of the spherical surface = Mean reading on spherical surface- Mean reading on plane glass plate

h =0.23 -0.2 =0.03 cm

(c)

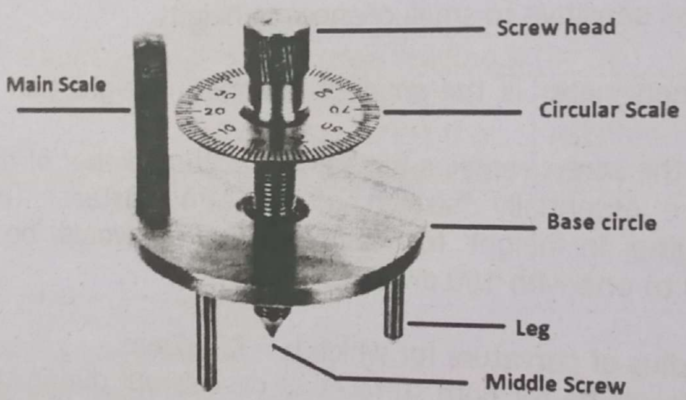
$$l = 3\,cm$$

$$R = \frac{l^2}{6h} + \frac{h}{2} = \frac{(3)^2}{6(0.03)} + \frac{(0.03)}{2} \approx 50\,cm$$

iii. For a convex surface, the reading on the spherical surface will be less than the reading on the plane surface, resulting in a negative value of the sagitta. For a concave surface, the reading on the spher surface will be greater than the reading on the plane surface, resulting in a positive value of the sagitta.

Solution: Practical Based Assessment (PBA) Sample Paper- 3

(i)



(ii) Add the main scale reading: 2.0 mm.
Add the circular reading: 75th division on the circular coinciding with the main scale line mea
75 x least count (usually 0.01 mm).

(a) Total reading : 2.0 mm + (75 x 0.01 mm) = 2.75 mm.

(b) Height h of the spherical surface =
Mean reading on spherical surface- Mean reading on plane glass plate

$$h = 2.75\,mm - 1.40\,mm = 1.25\,mm = 0.125\,cm$$

(c) Radius of curvature of spherical surface

$$R = \frac{l^2}{6h} + \frac{h}{2} = \frac{(3)^2}{6 \times 0.125} + \frac{0.125}{2} = 12.06\,cm$$

(iii) $$\%age\ uncertainty = \left(\frac{measured\ value - true\ value}{true\ value}\right)100$$

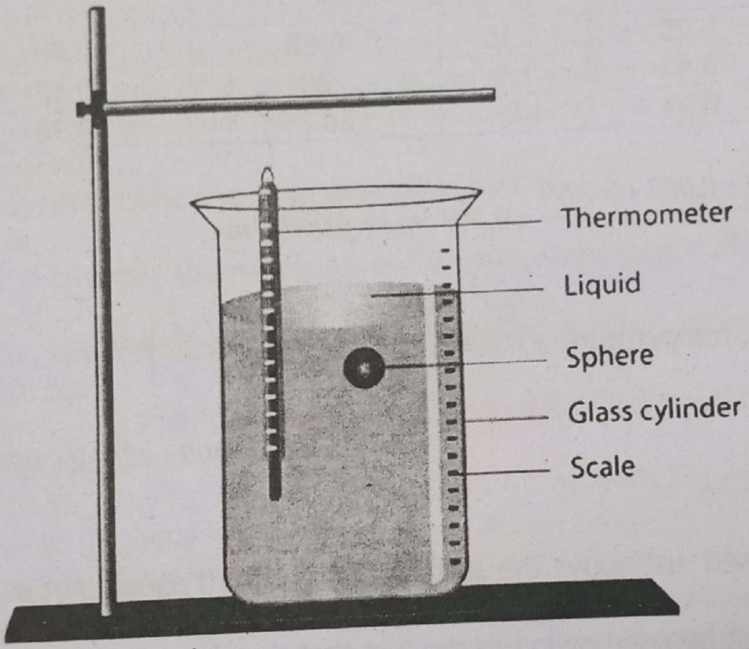
$$\%age\ uncertainty = \left(\frac{12.34 - 12.06}{12.06}\right)100 = 2.3\%$$

PRACTICAL 3

INVESTIGATE THE FALL OF SPHERICAL STEEL BALL THROUGH A VISCOUS MEDIUM AND DETERMINE COEFFICIENT OF VISCOSITY OF THE FLUID.

paratus

g wire bore glass tube fitted vertically and a meter rod attached with stopwatch, screw gauge, plumb line,
l balls having diameter 2-6mm, glycerin, strong magnet and thermometer



ocedure:

Adjust the tube vertical with help of leveling screw and plumb line.

Carefully fill the glass tube with glycerin to the top.

With the help of marker put two marks A and B on the tube near it lower end such that $AB = 0.1m$.

Measure the diameter of the steel ball. Release the steel ball into glycerin. The velocity of the steel ball slowly increases and becomes constant (equal to terminal velocity) near the lower end of the tube. When the steel ball reaches the point A start the stop watch and when it reaches B stop the stop watch. Find the corresponding time t.

Find terminal velocity by the equation $v_t = \frac{S}{t}$

Find the coefficient of viscosity η from the relation $\eta = \frac{2r^2(\rho_s - \rho_g)}{9v_t}$

Repeat the experiment taking steel balls of different diameters.

Find mean v_t and mean η.

plot a graph between r^2 and v_t. The graph is straight line.

Observation and Calculations:

Distance between $'x' \, and \, 'y' = \ell = 30cm$

Density of steel = $\rho_1 = 8500 \; kg \, m^{-3}$

Density of glycerin = $\rho_2 = 1260 \, kg \, m^{-3}$

Gravitational acceleration = $g = 9.8 ms^{-2}$

Temperature of glycerin $= 25 ^{\circ}C$

No Of obs	Mean diameter of ball bearing d	Radius $r = \frac{d}{2}$	Time of fall for xy t	Terminal Velocity $v = \ell / t$	r^2	$\frac{r^2}{v}$
	cm	cm	s	cm/s	cm^2	cms
1	0.35	0.175	9.01	$\frac{30}{9.01} = 3.33$	$(0.175)^2 = 0.03$	$\frac{0.03}{3.33} = 0.00$
2	0.50	0.25	4.35	6.89	0.06	0.009
3	0.84	0.42	1.5	20	0.18	0.009
4	1.02	0.51	1.04	28.35	0.26	0.009

$$mean \, \frac{r^2}{v} = \frac{(0.009 + 0.009 + 0.009 + 0.009)}{4} = 0.009 \; cm.s = 0.00009 \, m.s$$

Viscosity of glycerin at temperature $25 ^{\circ}C = \eta = \left(\frac{2}{9}\right) g \left(\rho_1 - \rho_2\right) \left(\frac{r^2}{v}\right)$

$$= \left(\frac{2}{9}\right) \times 9.8 \times \left(8500 - 1260\right) \left(0.00009\right) = 1.405 \, Ns \, m^{-2}$$

Precautions:

1. Steel ball should be released just above the surface of glycerin. It should not be dropped from a height.
2. Large steel balls should not be used owing to the fact that they have large terminal velocity which is difficult to measure.

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

Q.1. What is viscosity?

Ans: It is the property of the fluid or liquid by virtue of which it opposes relative motion between its different layers.

Q.2. What is coefficient of viscosity?

Ans: It is the tangential force per unit area required to maintain a unit velocity gradient.

$\left(\frac{\Delta v}{\Delta x}\right)$ in the fluid.

Q.3. What is the SI unit of coefficient of viscosity and its dimensional formula?

Ans: S.I unit of coefficient of viscosity is Dimensional formula is

$kg\,m^{-1}s^{-1}$ or $N.S.\,m^{-2}$

Dimensional formula is

$\eta = [ML^{-1}T^{-1}]$

Q.4. What is terminal velocity?

Ans. Terminal velocity is the constant speed that a falling object eventually reaches through a viscous fluid It is the velocity at which the gravitational force is equal to the resistive force of the fluid.

Q.5. How is viscosity of liquid and gasses affected by temperature?

Ans: Viscosity of a liquid decreases with increase of temperature. Viscosity of a gas increases with the increase of temperature.

Q.6. Distinguish between cohesive and adhesive forces.

Ans: **Cohesive force:**

Force of attraction between the molecules of the same substance is called cohesive force.

Adhesive Force:

Force of attraction between the molecules of different substances is called adhesive force.

Q.7. What is drag force?

Ans: When a body moves in a fluid the force which opposes the motion of the body is called drag force.

Q.8. What is Stoke's law?

Ans: According to Stoke's law when a sphere of radius r moves with a velocity v in a fluid of viscosity n. the drag force acting on the body is given by $F = 6\pi\eta rv$

Q.9. Differentiate between friction and viscosity?

Ans: When a solid slides over the surface of another solid, the force which opposes the motion of the sliding body is called friction. The force which opposes the motion of one layer of the fluid with respect to another layer is called viscosity.

Q.10. What is stream line flow?

Ans: It is such a flow in which the velocity at every point in the liquid remains constant (both in magnitude and direction). Each particle follows exactly the same path one after the other.

Q.11. Identify two significant sources of random error in viscosity measurement experiment and explain how each can be minimized.

Ans: (i) Timing the fall: Human reaction time when starting and stopping the stopwatch introduces a random error. This can be minimized by using a longer fall distance, as the effect of the reaction time becomes a smaller percentage of the total time.

(ii) Measuring the diameter of the ball: A small error in measuring the diameter (d) of the ball leads to a large error in the radius squared.

Q.12. Explain why a heavier sphere of larger radius reaches terminal velocity more quickly than a smaller one.

Ans: Greater weight → larger driving force
higher viscous drag builds up faster → reaches equilibrium (terminal velocity) sooner .

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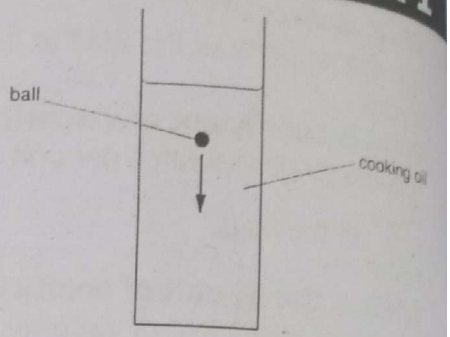
PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER 1

Q. A student is investigating the motion of a small steel ball in cooking oil. A measure of the oil's resistance to the ball's motion is called viscosity. Viscosity has the units pascal second (Pa s).

The student drops a ball into a cylinder of oil. The velocity of the ball is measured when it becomes constant and then the viscosity of the oil is determined.



(i) Explain why it is important to wait for the ball to reach terminal velocity before starting the timing. (1)

(ii) If a steel sphere of radius $r = 2.0 \times 10^{-3}\,m$ falls with terminal velocity. The cooking oil density is $920\,kg\,m^{-3}$ and steel density is $7850\,kg\,m^{-3}$. Calculate the viscosity coefficient. (2)

Sr. No.	Time $t(s)$	Terminal velocity $v_t = \frac{\ell}{t} = \frac{0.100}{t}$ $(m\,s^{-1})$	Viscosity
1	0.45	0.23	
2	0.50	0.20	
3	0.48	0.21	

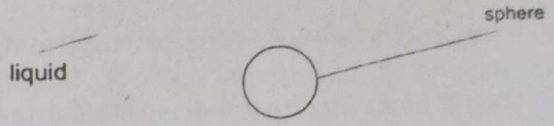
(iii) State and explain the effect of temperature on viscosity of liquids. (1)

(iv) What is the expected relationship between the square of radius of the steel ball r^2 and its terminal velocity v_t? (2)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER 2

Q. Motor-oil companies rate engine oils by their "kinematic viscosity"

In an experiment, students drop spherical steel ball into a column of engine oil and use timing gates to record the time taken to fall a fixed distance after reaching terminal velocity. The goal is to calculate the viscosity of the oil.



(i) Show that the SI base units of viscosity are $kg\,m^{-1}\,s^{-1}$. (1)

(ii) The spherical steel ball has a radius of 1.4 mm and is falling vertically downwards at a terminal velocity of 10.0 cm s^{-1} through the fluid.

Where Density of steel $= \rho_{steel} = 7850\,kg\,m^{-3}$ *and Density of* Motor-oil $= \rho_{motor\,oil} = 870\,kg\,m^{-3}$

(a) The sphere is shown in Fig. Draw and label arrows to represent the directions of the three forces acting on the sphere as it falls at terminal velocity through the liquid. (1)

(b) Calculate the viscosity of the liquid. (2)

(iii) The student repeats the measurement with a second ball of the same diameter but half the mass. Explain whether the new terminal speed will be greater, smaller or the same. (1)

(iv) Suggest one modification to the setup to improve the accuracy of the viscosity determination, and explain your reasoning. (1)

Solution: Practical Based Assessment (PBA) Sample Paper 1

(i) The coefficient of viscosity is determined using Stokes' Law, which is only valid when the objec moving at its terminal velocity. Starting the timing before the ball reaches this constant speed wou result in an incorrect inaccurate calculation of viscosity.

(ii)

Sr. No.	Time $t(s)$	Terminal velocity $v_t = \frac{\ell}{t} = \frac{0.100}{t}$ (ms^{-1})	Viscosity $\eta = \left(\frac{2}{9}\right) g(\rho_1 - \rho_2)\left(\frac{r^2}{v}\right)$
1	0.45	0.23	0.272
2	0.50	0.20	0.302
3	0.48	0.21	0.290

$$\eta_{mean} = \frac{0.272 + 0.302 + 0.290}{3} = 0.289\,kg\,m^{-1}\,s^{-1}$$

$$\eta_{cooking\,oil} = 0.289\,kg\,m^{-1}s^{-1} \approx 0.289\,Pa.s$$

(ii) Viscosity of liquids decreases with increasing temperature

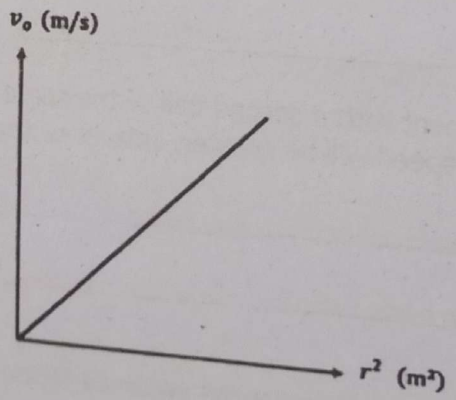
Explanation:

Because higher temperature reduces intermolecular forces , increases molecular separation that's lead to lower resistance to motion.

(iv) The terminal velocity is directly proportional to the square of its radius

$$v_t = \frac{2r^2\left(\rho_{steel\,ball} - \rho_{cooking\,oil}\right)g}{9\eta}$$

$$v_t \propto r^2$$



Solution: Practical Based Assessment (PBA) Sample Paper 2

(i)

Units of $F = kg\,m\,s^{-2}$,Units of $r = m$, and units of $v = m\,s^{-1}$

Units of $\eta = \frac{kg\,m\,s^{-2}}{m \times m\,s^{-1}} = kg\,m^{-1}s^{-1}$

(ii) (a)

- One arrow vertically downwards labelled weight / W
- Arrows vertically upwards labelled U/ upthrust and drag / FD / viscous force

(b)

$$\eta = \left(\frac{2}{9}\right) g\left(\rho_s - \rho_f\right)\left(\frac{r^2}{v}\right)$$

$$\eta = \left(\frac{2}{9}\right)(9.81)(7850-870)\left[\frac{\left(1.4\times10^{-3}\right)^2}{0.1}\right] = 0.3\,kg\,m^{-1}s^{-1}$$

(iii)

New terminal speed will be smaller.

Explanation:

At terminal velocity drag = weight

Smaller weight → smaller drag needed → smaller v

(iv)

a. Use a longer column to ensure terminal velocity is reached earlier/reduce entry effects.
b. Control temperature as viscosity varies with it.

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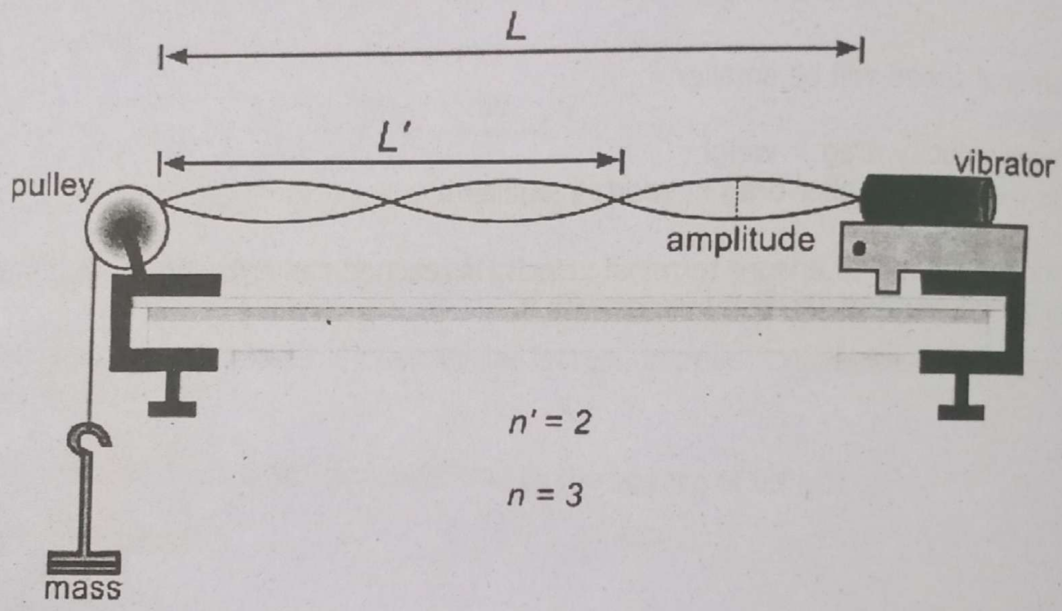
PRACTICAL 4

STUDY STATIONARY WAVES USING MELDE'S APPARATUS AND CALCULATE THE FREQUENCY OF AC SOURCE.

Apparatus

Sonometer with non-magnetic wire (Nichrome), Ammeter, step down transformer (2-10 Volts), Ke shoe magnet, Wooden stand for mounting the magnet , Set of 50 gm masses, Screw gauge and me (fitted with the sonometer).



Procedures

i. Take a uniform thread of one meter long and attach its one end to the strip and the other to a light passing it over a frictionless pulley.
ii. Place an electric vibrator in the transverse position.
iii. Find the mass of five meter long thread through balance and then calculate mass per unit lengt denoted by 'm'.
iv. Connect the A.C. mains to the solenoid of an electric vibrator.
v. Switch on the A.C current so that it passes through an electric vibrator. Thus the changing magnet produces vibrations in the strip.
vi. Add small weights in the pan such that the string vibrates in one loop with maximum amplitude und forced vibrations of the strip.
vii. Note the tension T (=weight of the pan + weights added) and measure the length L of the loop.
viii. By reducing the tension, the string is made to vibrate in two, three, four loops and so on.
ix. Calculate the frequency of A.C. mains by using formula

$$f=\frac{1}{2L}\sqrt{\frac{T}{m}}$$

Observations

Length of the wire = 500 cm = 5 m

Mass of the wire = 0.79 g

Mass per cm of the wire =m=1.58×10^{-3} g

No. of obs.	No. of loops (n)	Distance between extreme nodes L (cm)	Length of each loop $\ell=\frac{L}{n}$ (cm)	mass of pan + mass added $M=m_1+m_2$ (g)	Tension T=Mg =M(981) (dynes)	Frequency of vibrating segment $f=\frac{1}{2L}\sqrt{\frac{T}{m}}$ (Hz)
1	1	39	39	30.32	29743.92	55.60
2	1	47	47	40.55	39779.55	53.38
3	1	49.5	49.5	50.21	49256.01	56.40

Mean natural frequency of sonometer Frequency = 55.13 Hz

Standard frequency = 50Hz

$$\%age\,uncertainty=\left(\frac{measured\ value-true\ value}{true\ value}\right)100=\left(\frac{55.13-50}{50}\right)100=4\%$$

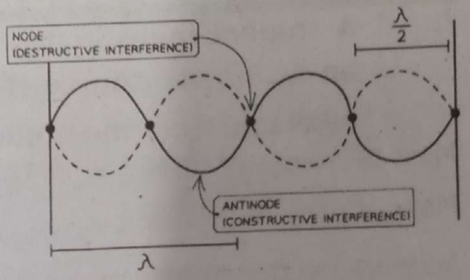
POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

1. **Explain the principle behind Melde's apparatus. How does the AC current cause the wire to vibrate?**

Ans. AC current makes the wire vibrate through magnetic interactions. Vibrations create standing waves on the wire.

2. **Define a stationary (standing) wave.**

Ans: The resultant wave produced when two identical progressive waves travel through the same region in opposite directions and superpose; it shows alternate nodes (zero amplitude) and antinodes (maximum amplitude) which are fixed in position



3. **Define the terms: Node and Antinode.**

Ans: Node: A point of zero amplitude in a stationary wave where the medium does not vibrate.
Antinode: A point of maximum amplitude in a stationary wave.

4. **What is the distance between two consecutive nodes or two consecutive antinodes?**

Ans: The distance between two consecutive nodes (or two consecutive antinodes) is λ/2, where λ is the wavelength of the progressive waves forming the stationary wave.

5. **How do you create a stationary wave in the string?**

Ans: By adjusting the tension in the string (by adding/removing weights) until clear and stable loops are formed. This happens when the length of the string is an integral multiple of half the wavelength

6. **What do you mean by a 'loop' or 'segment'?**

Ans: A single loop corresponds to the portion of the string between two consecutive nodes. It is half of a complete wavelength. $L=n\left(\frac{\lambda}{2}\right)$

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7. **What is the formula for the frequency (f) of the wave in the string?**

Ans: $f = \frac{1}{2L}\sqrt{\frac{T}{m}} = \frac{1}{\lambda}\sqrt{\frac{T}{m}}$

8. **If the tension is increased, what happens to the number of loops formed?**

Ans: The number of loops increases.
Explanation:

$f = \frac{1}{\lambda}\sqrt{\frac{T}{m}}$ $\qquad$ $f \propto \frac{\sqrt{T}}{\lambda}$

An increase in T requires a decrease in λ to keep f constant, which means number of loops increase

9. **Mention any two applications of Melde's experiment.**

Ans: Determination of unknown frequency of a tuning fork or A.C. supply.
Demonstration of dependence of wave velocity on tension and linear density

10. **Which is more dangerous in use A.C. or D.C.? Why?**

Ans. AC's rapid direction changes mess with muscles, making "letting go" hard. It can also disrupt your heart rhythm and lower skin resistance, amplifying the danger. DC acts like a constant pull, but hig voltages of AC are still serious.

11. **Why is D.C. supply unsuitable for this experiment?**

Ans: With D.C. the core is magnetised in one direction only and no oscillatory force is produced, so the s does not vibrate

12. **Describe some potential sources of error in the experiment.**

Ans:
- Pulley may not be frictionless.
- Weights may not be correct.
- The main frequency may not be stable.

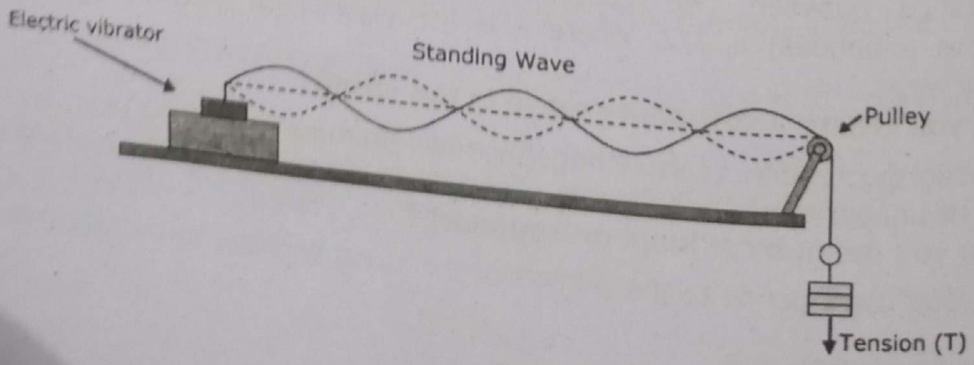
PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER 1

Q. **A student investigates standing waves on a string using Melde's apparatus connected an AC power source. The string vibrates in a number of loops (n). The following data available from the student's experiment:**

Mass of $300\,cm$ of thread $= 0.65\,g$

Mass of pan, $m_1 = 12.52\,g$

Acceleration due to gravity $g = 981\,cm s^{-2}$



(i) Calculate the mass per unit length, m, of the thread in $g\,cm^{-1}$. (1)

(ii) Complete the table by calculating the missing values (2)

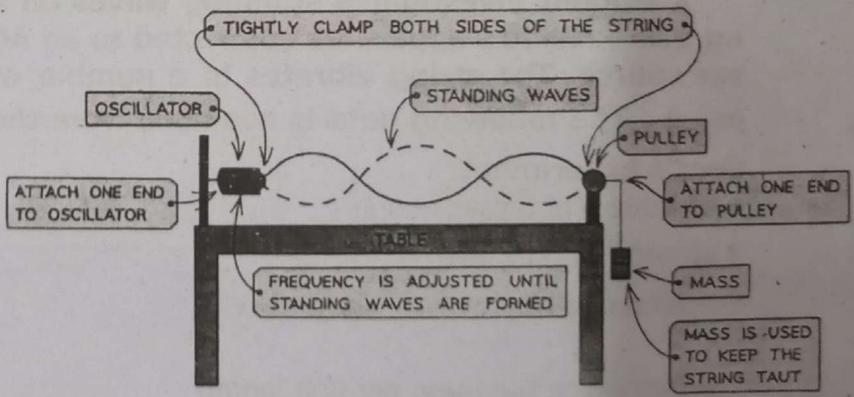
No. of obs.	No. of loops (n)	Distance between extreme nodes L (cm)	Length of each loop $\ell = \frac{L}{n}$ (cm)	mass of pan + mass added $M = m_1 + m_2$ (g)	Tension T=Mg (dynes)	Frequency of vibrating segment (Hz)
1	2	45.6	22.8	32.52		
2	2	58	29	52.52		
3	2	68	34	72.52		

Mean value :____________

(iii) How many nodes and anti-nodes are there if $n = 4$ (2)

(iv) Explain whether the frequency should increase or decrease when L increases for same loops. Justify.(1)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER 2


TIGHTLY CLAMP BOTH SIDES OF THE STRING
OSCILLATOR
STANDING WAVES
PULLEY
ATTACH ONE END TO OSCILLATOR
ATTACH ONE END TO PULLEY
TABLE
FREQUENCY IS ADJUSTED UNTIL STANDING WAVES ARE FORMED
MASS
MASS IS USED TO KEEP THE STRING TAUT

Q. Students perform Melde's experiment to investigate stationary waves on a steel strip connected to a thread, using an electromagnet driven by an AC supply. The thread's mass is 0.34 g over 100 cm, with a pan mass of 10.0 g. Tension is varied by adding weights, and g = 981 cm/s². The table records the number of loops (n), distance between extreme nodes (L), and total mass on the pan (M).

Mass per unit length, m, of the thread in $g\,cm^{-1}$.

Determine the mass per unit length

ill in the missing values in the table.

of	No. of loops (n)	Distance between extreme nodes L (cm)	Length of each loop (cm)	mass of pan + mass added $M = m_1 + m_2$ (g)	Tension T=Mg (dynes)	Frequency vibrating s (Hz)
	1	35		40		
	2	59		30		
	3	112		50		

n value :

What happen to frequency if length of string is kept constant and tension is increased nine tim

Show the distance between two adjacent nodes in stationary wave with diagram?

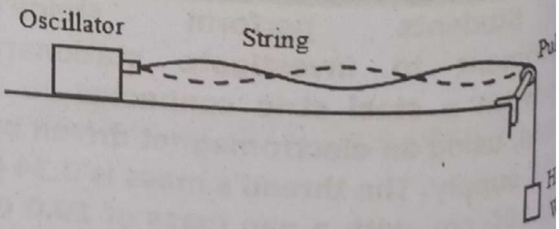
RACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPE

A student investigates standing waves on a ng using Melde's apparatus connected to an AC ver source. The string vibrates in a number of ps(n). The following data is available from the dent's experiment:

s of $200\,cm$ of thread $= 0.50\,g$

s of pan, $m_1 = 15.00\,g$

eleration due to gravity $g = 981\ cm\,s^{-2}$



Determine the mass per unit length

(ii) Fill in the missing values in the table.

No. of loops (n)	Distance between extreme nodes L (cm)	Length of each loop (cm)	mass of pan + mass added $M = m_1 + m_2$ (g)	Tension T=Mg (dynes)	Frequency of vibrating segr (Hz)
2	120	60	80+15=95		

(iii) How stationary waves are formed in Melde's apparatus?

(iv) Describe some potential sources of error in the experiment.

Solution: Practical Based Assessment (PBA) Sample Paper

(i)

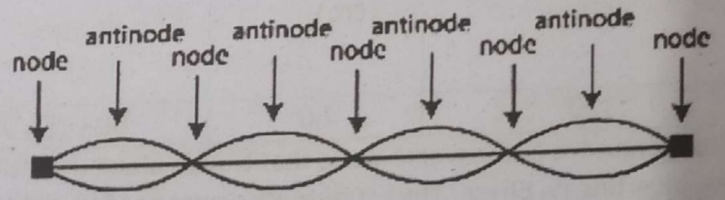
$$m = \frac{mass}{lenght} = \frac{0.65g}{300\,cm} = 0.0022\,g\,cm^{-1}$$

(ii)

No. of obs.	No. of loops (n)	Distance between extreme nodes L (cm)	Length of each loop $\ell = \frac{L}{n}$ (cm)	mass of pan + mass added $M = m_1 + m_2$ (g)	Tension T=Mg (dynes)	Frequenc vibrating se $f = \frac{1}{2L}\sqrt{\frac{T}{m}}$
1	2	45.6	22.8	32.52	31902.12	$49.8H$
2	2	58	29	52.52	51522.12	$49.8H$
3	2	68	34	72.52	71142.12	$49.9H$

Mean value $= 49.8Hz$

(iii) node=5,
antinode=4



(iv)

$$f = \frac{1}{2L}\sqrt{\frac{T}{m}} \qquad L\uparrow \quad f\downarrow$$

Wave becomes longer → lower frequency required

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Solution: Practical Based Assessment (PBA) Sample Paper

(i) $m = \frac{mass}{lenght} = \frac{0.34g}{100cm} = 0.0034\,g\,cm^{-1}$

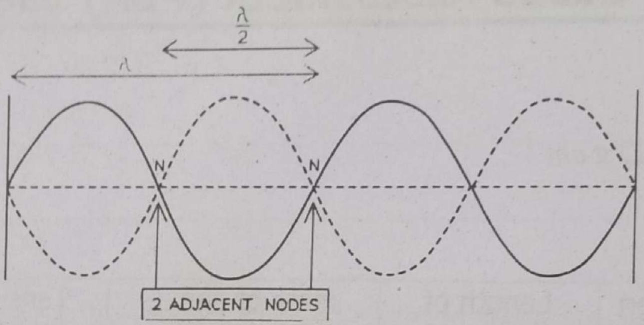
(ii)

No. of obs.	No. of loops (n)	Distance between extreme nodes L (cm)	Length of each loop $\ell = \frac{L}{n}$ (cm)	mass of pan + mass added $M = m_1 + m_2$ (g)	Tension T=Mg (dynes)	Frequency vibrating se $f = \frac{1}{2L}\sqrt{}$
1	1	35	35	40	39200	48.
2	2	59	29.5	30	29400	49
3	3	112	37.5	50	49000	50

Mean value $= 49.7Hz$

(iii) $f = \frac{1}{2L}\sqrt{\frac{T}{m}}$ $\qquad f' = \frac{1}{2L}\sqrt{\frac{9T}{m}} = 3\left[\frac{1}{2L}\sqrt{\frac{T}{m}}\right] = 3f$

(iv)



Solution: Practical Based Assessment (PBA) Sample Paper

(i)

$m = \frac{mass}{lenght} = \frac{0.5g}{200\,cm} = 0.0025\,g\,cm^{-1}$

(ii)

No. of loops (n)	Distance between extreme nodes L (cm)	Length of each loop (cm)	mass of pan + mass added $M = m_1 + m_2$ (g)	Tension T=Mg (dynes)	Frequency of segment $f = \frac{1}{2L}\sqrt{\frac{T}{m}}$
2	120	60	80+15=95	93100	50.85

(iii) A vibrator generates a transverse wave that travels along the string towards the pulley. The wave is reflec the fixed pulley, inverting its phase. Thus stationary waves are formed in Melde's apparatus through the superpo of two identical waves traveling in opposite directions along the stretched string.

(iv)

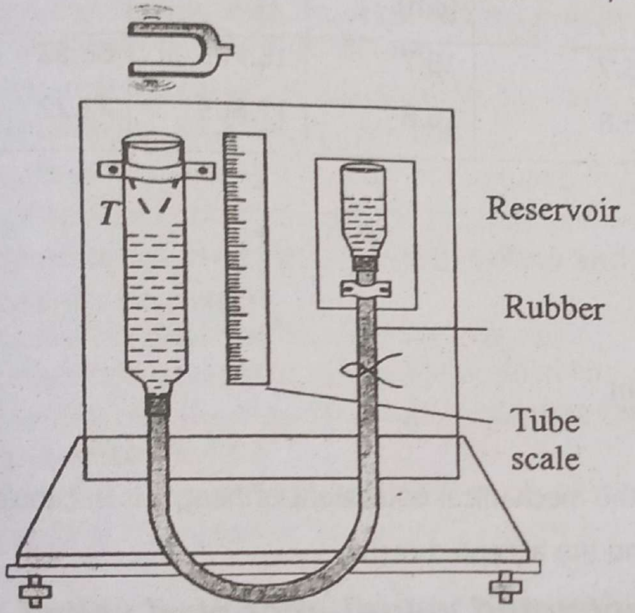
- Pulley may not be frictionless.
- Weights may not be correct.
- The main frequency may not be stable.

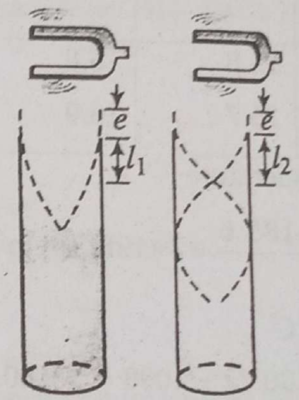
PRACTICAL 5

DETERMINE THE WAVELENGTH OF SOUND IN AIR USING STATIONARY WAVES AND TO CALCULATE THE SPEED OF SOUND AT 0°C USING RESONANCE TUBE.

paratus

nance tube apparatus , Thermometer ,Set of tunning forks , Set square , Rubber pad, Vernier calliper.





cedures

ill the tube and the water supply container with water from the water can until the water level in the tube s within 10 cm of the top of the tube.

Hold the thermometer in the tube and measure the temperature, T, of the air.

Hold the tuning fork at its yoke and either strike the tines with the rubber mallet.

Hold the tuning fork over the open end of the tube and slowly lower the water level in the tube by owering the water supply container until resonance is achieved.

The water level in the tube now represents the position of a node. Record the water level position, L_1

Again strike the tuning fork and hold it over the tube. Lower the water supply container further, and again determine the water level position for resonance.

Record this level, L_2. Note that the distance $L_2 - L_1 = L$ corresponds to one-half a wavelength.

Repeat the above procedures for the other tuning fork.

servations

m temperature at the beginning of experiment = t_1 = 18C°

m temperature at the end of experiment = t_2 = 18C°

nperature $t = \frac{t_1 + t_2}{2} = \frac{18 + 18}{2} = 18C^\circ$

ernal diameter of tube $D = \frac{3.35 + 3.35}{2} = 3.35cm$

of upper end of tube against scale X=0cm

0.3D= 0.3 x 3.35cm = 1.005 cm

Frequency of tunning fork f (Hz)	Position of water level when water		Mean $L_1 = \frac{\ell_1 + \ell_2}{2}$ (cm)	Length of resonant column $L' = (L_1 - X)$ (cm)	Corrected length $L = L' + 0.3D$ (cm)	Wave length $\lambda = 4L$ (cm)	$V_t = f\lambda$ (cm/sec
	Falling ℓ_1(cm)	Rising ℓ_2 (cm)					
512	15.8	15.8	15.7	15.7	16.705	66.82	34211.8
480	16.7	16.9	16.8	16.8	17.805	71.22	34185.6

locity at temperature "t"

$\frac{211.84 + 34185.6}{2} = 34198.72 cm / s$

sound at 0 C°

61 t = 34198.72 – 1098 = 33100.72 cm

00.72 cm/s

your result with the accepted value of the mechanical equivalent of heat, J is 4.2 Joules/Calories.

the percent difference in your result and the accepted result.

difference = [(your result – accepted value)/accepted value] x 100%

Speed of sound at 0 C° is 33240 cm/s

age error $= \left|\frac{33100.72 - 33240}{33240}\right| \times 100\% = 0.4\%$

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

efine the sound wave and what are the types?

ound waves are invisible disturbances that travel through mediums like air, water, or solids.

ound waves can be categorized by Frequency: Audible (human hearing), infrasonic (below hearing), ltrasonic (above hearing).

ound waves are classified as mechanical and pressure waves.

he distance between the two resonance positions (the distance between adjacent nodes) s 1/2λ. Why?

Standing waves occur when waves reflect back on themselves. For resonance (strong vibration), th confined space matches an integer multiple of half the wavelength. So, moving one resonance furthe adds another half wavelength, meaning the distance between two nodes (points with no vibration) i alf the wavelength. Like two points on a vibrating string with fixed ends, spaced half the wave ngth.

In this experiment when does the resonance take place?

s. When frequency of tuning fork is equal to fundamental note or first harmonic

In this experiment should you take a low frequency or high frequency tuning fork?

s. Tuning fork should be of low frequency (about 256 Hz) because for higher frequency a larger leng resonance tube is required.

Explain why the velocity of sound increases as the temperature increases.

s. The speed of sound varies directly as the square root of absolute temperature, i.e.,

$$v \propto \sqrt{T}$$

It means that greater the temperature of air more will be speed of sound in it.

$$v = 332 + 0.61t\,^{o}C$$

Thus the increase in the speed of sound for each degree rise above 0 °C is 0.61 m s^{-1}.

Explanation:

Molecules at higher temperatures have more energy, thus they can vibrate faster. Since the molecu vibrate faster, sound waves can travel more quickly.

What are the conditions that must be satisfied to produce a standing wave in a tube ope at one end and closed at the other end?

- Wave interference between oppositely traveling waves
- Node at closed end, antinode at open end
- Wavelengths in multiples of a quarter of the tube's length
- Resonance between driving frequency and tube's normal modes

Explain why readings are taken for both falling and rising water levels.

i. To reduce systematic error
ii. To avoid uncertainty in exact resonance level
iii. Water surface oscillates leads to average position improves accuracy

Describe one key observation that indicates that the resonance has been successfully located at the water level L

s: A sudden significant increase in the loudness of the sound is heard.
The column of air is resonating at its natural frequency or maximum amplitude when the sound is loudest

How could you use the resonance tube setup method and the results of this experiment determine whether the speed of sound in air depends upon its frequency?

s: **The speed of sound in air is independent of its frequency.**

Explanation:

let use the resonance tube setup but with a wide range of tuning forks of different frequencies (e 256 Hz, 320 Hz, 480 Hz, 512 Hz, 1024 Hz).

For each frequency f, compute the speed of sound.

If the calculated speed of sound v is approximately the same for all the different frequencies us then the results indicate that the speed of sound in air is independent of its frequency

). **When sound waves pass from air into water, their speed increases by a factor of 4. This means that either the wavelength or the frequency also increases by a factor of 4. Which it? Explain.**

ns: When sound waves pass from air into water, the frequency remains the same, and the wavelength increases by a factor of 4.

Explanation:

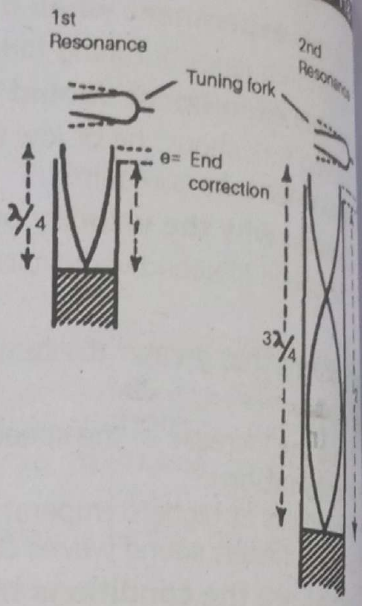
The frequency of a wave is determined by the source that created it.

When a sound wave is transmitted from one medium to another, the frequency does not change; source forces the oscillation at the boundary to match its own frequency.

Each oscillation takes the same time, but in faster medium the disturbance travels farther during period, so wavelength grows.

11. Why does the closed end form a node and open end an antinode?

Ans: At the closed end air displacement is zero (node); at an open end air is free to move so displacement is maximum (antinode).



12. What is end correction and why needed?

Ans: The phenomenon where the antinode does not form exactly at the open end of the tube, but slightly outside it. We have to add a small correction e to the measured length; e≈0.3D

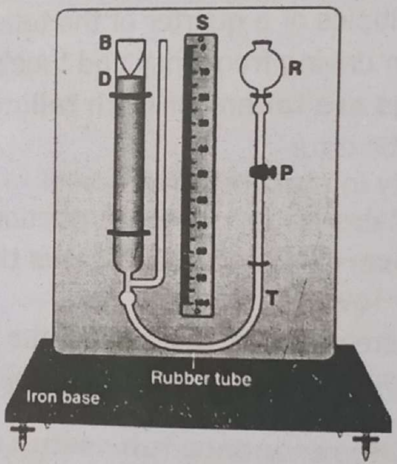
13. What is sources of error using resonance tube method?

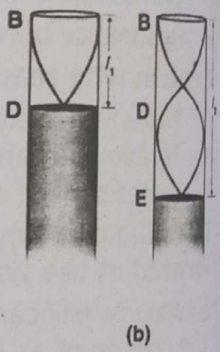
Ans:

- Wrong identification of resonance (hearing faint maxima)
- Uncertainty in length measurement
- Temperature differences
- tube radius not uniform
- wind/noise

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER-

Q. Students perform a resonance tube experiment to find the wavelength of sound using stationary waves, employing tuning forks and measuring resonant positions with a closed-end tube. They account for end correction and plan to graph the data to verify the speed of sound. The experiment is conducted at 25°C, and the tube has an inner diameter of 1.5 cm.





(b)

(i) Describe the procedure to obtain accurate resonant lengths, including how to measure falling and rising positions and why averaging is used. (1)

(ii) The following table shows partial data. Fill in the corrected length L (using $e = 0.3d$), wavelength and speed v for each observation. (2)

Frequency of tunning fork f (Hz)	Mean L_1 (cm)	Corrected length $L = L_1 + e$ (cm)	Wave length $\lambda = 4L$ (cm)	velocity $v = f\lambda$ (cm s^{-1})
440	19.2	19.65		
512	16.4	16.85		
600	14.0	14.45		

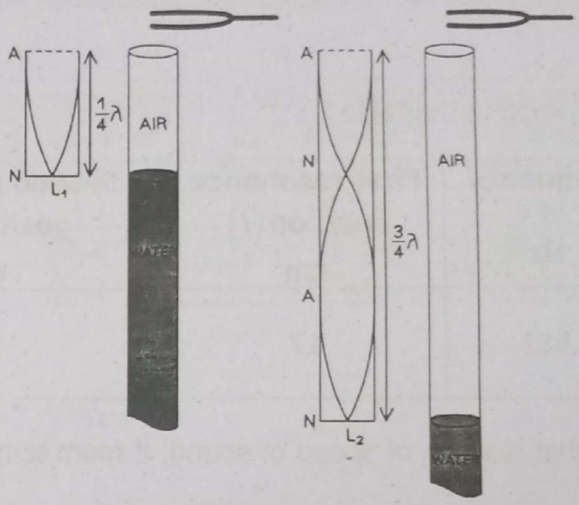
(iii) Why was it necessary to measure the diameter of the air column? (1)

(v) Explain why the velocity of sound increases as the temperature increases. (2)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

Q. In an experiment to determine the wavelength of sound in air using a resonance tube, students use tuning forks of known frequencies and adjust the water level to find the first resonance positions for falling and rising levels. They record the data in a table, aim to calculate the speed of sound at 0°C. The room temperature is 20°C, and the end correction is e = 0.3d, where d is the tube diameter in cm.

(i) The students obtain the following incomplete table for resonant lengths using a tube with d = 2.0 cm. Complete the table by calculating the mean resonant length L_1, the wavelength λ, and the speed of sound v at room temperature for each frequency.



(3)

Frequency f Hz	ℓ_1 (falling) cm	ℓ_2 (rising) cm	Mean $L_1 = (\ell_1 + \ell_2)/2$ cm	Corrected length $L = L_1 + e$ cm	Wave length $\lambda = 4L$ cm	velocity $v = f\lambda$ cm s^{-1}
256	32.4	32.6		33.1		
320	25.8	26.0		26.5		
384	21.4	21.6		22.1		

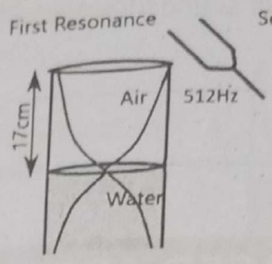
(ii) Using the formula v = v0 + 0.6t, where t is the room temperature in °C, calculate v0, the speed of sound at 0°C, from the average v in the table. (1)

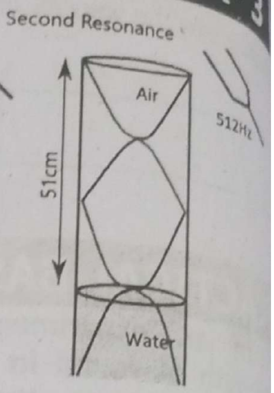
(iii) What is end correction and why needed? (1)

(iv) Identify two significant sources of random error in determining the resonant length and suggest a practical way to minimize one of them. (1)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 3

Q. In an experiment to determine the wavelength of sound in air using a resonance tube, students use a tuning fork of frequency 512 Hz placed above a tube partially filled with water. They adjust the water level to vary the air column length and record the positions of the first resonance (L_1) and second resonance (L_2) for different trials, noting an end correction of 0.3 cm.


First Resonance


Second Resonance

(i) Complete the table (2)

Frequency f Hz	First resonance position (l) cm	Second resonance position (l') cm	Wave length cm	velocity cm s^{-1}
512	17	51		

(ii) what is value of speed of sound, if room temperature is 20 °C? (2)

(iii) Suggest one modification to the experiment that would allow a more accurate determination of the end correction. (2)

Solution: Practical Based Assessment (PBA) Sample Paper- 1

(i) Use tuning fork struck gently, lower tube into water or adjust water level until loud resonance; note position for falling (decreasing length) and rising (increasing length) to account for friction; average ℓ_1 and ℓ_2 to get mean L_1 for accuracy

(ii)

Frequency of tunning fork f (Hz)	Mean L_1 (cm)	Corrected length $L = L_1 + e$ (cm)	Wave length $\lambda = 4L$ (cm)	velocity $v = f\lambda$ (cm s^{-1})
440	19.2	19.65	78.6	34584
512	16.4	16.85	67.4	34508.8
600	14.0	14.45	57.8	34680

(iii) Because of the correction term; the wave exists partially above the top of the tube

(iv) The speed of sound varies directly as the square root of absolute temperature, i.e.,

$$v \propto \sqrt{T}$$

Explanation:
Molecules at higher temperatures have more energy, thus they can vibrate faster. Since the molecules vibrate faster, sound waves can travel more quickly.

Solution: Practical Based Assessment (PBA) Sample Paper- 2

(i)

Frequency f Hz	ℓ_1 (falling) cm	ℓ_2 (rising) cm	Mean $L_1 = (\ell_1 + \ell_2)/2$ cm	Corrected length $L = L_1 + e$ cm	Wave length $\lambda = 4L$ cm	velocity $v = f\lambda$ cm s^{-1}
256	32.4	32.6	35.5	33.1	132.4	33894.4
320	25.8	26.0	25.9	26.5	106	33920
384	21.4	21.6	21.5	22.1	88.4	33945.6

(ii)

$$v_{ave} = \frac{33894.4+33920+33945.6}{3} = 33920\,cm\,s^{-1}$$

$$v = v_0 - 0.6t$$

$$v_0 = v - 0.6t = 33920\,cm\,s^{-1} - 0.6(20) = 33908$$

(iii) The phenomenon where the antinode does not form exactly at the open end of the tube, but slightly outside it. We have to add a small correction e to the measured length; e≈0.3D

(iv) Make sure the marker is a thin line to get a more accurate reading of the water level
Submerge the tube into the water slowly, so the antinode of the sound wave (loudest sound) is not missed

Solution: Practical Based Assessment (PBA) Sample Paper- 3

(i)

Frequency f Hz	First resonance position (l) cm	Second resonance position (l') cm	Wave length $\lambda = 2(l' - l)$ cm	velocity $v = f\lambda$ cm s^{-1}
512	17	51	68	34816

(ii) $v = v_0 - 0.6t = 348.16 - 0.6(20) = 336.16\,ms^{-1}$

(iii)

Use multiple resonances (first, second, third) and extrapolate to find end correction.
Slowly adjust water level while listening for maximum loudness or use a microphone system to detect resonance more precisely.

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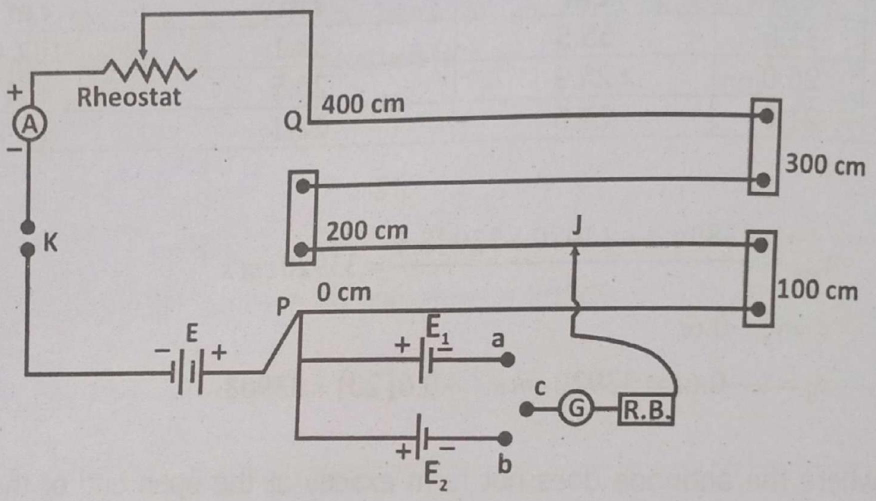
PRACTICAL 6

COMPARE THE EMF OF CELLS USING POTENTIOMETER

Apparatus:

Potentiometer , Key , Cell, Power supply, Galvanometer, Jockey, Rheostat,

Diagram



Procedure:

1. Connect circuit insuring positive of both E and cell Ex are connected to A Negative through key to
2. Ex was connected between A and G1
3. Locate balancing length were galvanometer show no defection from A to C
4. Determine number of length by changing resistance by rheostat
5. Calculate Ex by formula $E_x = E\left(\frac{\ell}{L}\right)$
6. Emf of two cells can be compare by formula $\frac{E_1}{E_2} = \frac{\ell_1}{\ell_2}$

Observations:

Length of potentiometer wire AB = L = 400 cm.

Table:

Observation	Emf of cell E (volt)	for E_1 (cm)	(cm)	$\frac{E_1}{E_2}$ = ____
1	3	269	181	1.48
2	3	340	255	1.33
3	3	335	255	1.31

Calculations: Mean value = 1.37

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

1. What is a potentiometer?

Ans: A potentiometer is an electrical apparatus used for precise calculation of small potential differences and to analyze the EMFs of the available primary cells.

2. What is the principle of a potentiometer?

Ans: For a constant current, the fall of potential in a wire is directly proportional to the wire's length.

3. What are characteristics of wire of potentiometer?

Ans: Uniform area, high resistivity, low temperature coefficient

4. Which material is used for the potentiometer wire?

Ans: The alloys of constantan and manganin are used to make potentiometer wires because they have high resistivity and low- temperature coefficient of resistance.

5. What will result if the cross-section area of the potentiometer wire is non-uniform?

Ans: The potential difference across the wire will not be proportional to its length.

6. Define potential gradient of a potentiometer?

Ans: The potential drop per unit length of the potentiometer wire is called potential gradient.

7. What is meant by a cell's EMF?

Ans: It is the highest possible potential difference along with a cell's terminals in an open electric circuit.

8. What is meant by terminal voltage?

Ans: Terminal voltage is the potential difference along with a cell's terminals when the electric current is being taken from it.

9. What is the balance point in the potentiometer?

Ans: The balancing point on the slide wire of a potentiometer in the point where the galvanometer attached to the potentiometer shows zero deflection

10. What is the reason behind the null point?

Ans: The null point is acquired because the cell's e.m.f. is balanced by the potential variation along a particular length of the connected potentiometer wire.

11. Is a voltmeter used for measuring the e.m.f.?

Ans: No, the voltmeter takes electric current from the cell.

12. When terminal potential is equal to e.m.f of cell?

Ans: Terminal potential and e.m.f if a cell are related as $\varepsilon = V_t + Ir$. When current is zero, then $\varepsilon = V_t$

13. How do you compare the EMF of two cells using a potentiometer?

Ans: Connect one cell at a time using a two-way key, and find the balancing length for each cell. The ratio of the two balancing lengths is the comparison of the two cells' EMFs

14. Why is a potentiometer preferred over a voltmeter for the calculation of EMF?

Ans: For the purpose of measuring EMF accurately, no electric current should be taken from the cell. In the case of a , the readings are noted when the electric current is zero. So the potentiometer measures the EMF correctly.

15. What can be the reason for one-sided deflection in galvanometers?

Ans: (a) The primary cell's EMF may surpass that of the main circuit cell.
(b) Circuit connections may be incorrect or loose.

16. What are the applications of a potentiometer?

Ans: A potentiometer is used to

- Compare the emf of two cells
- Measure emf of a cell
- Determine the internal resistance of a cell

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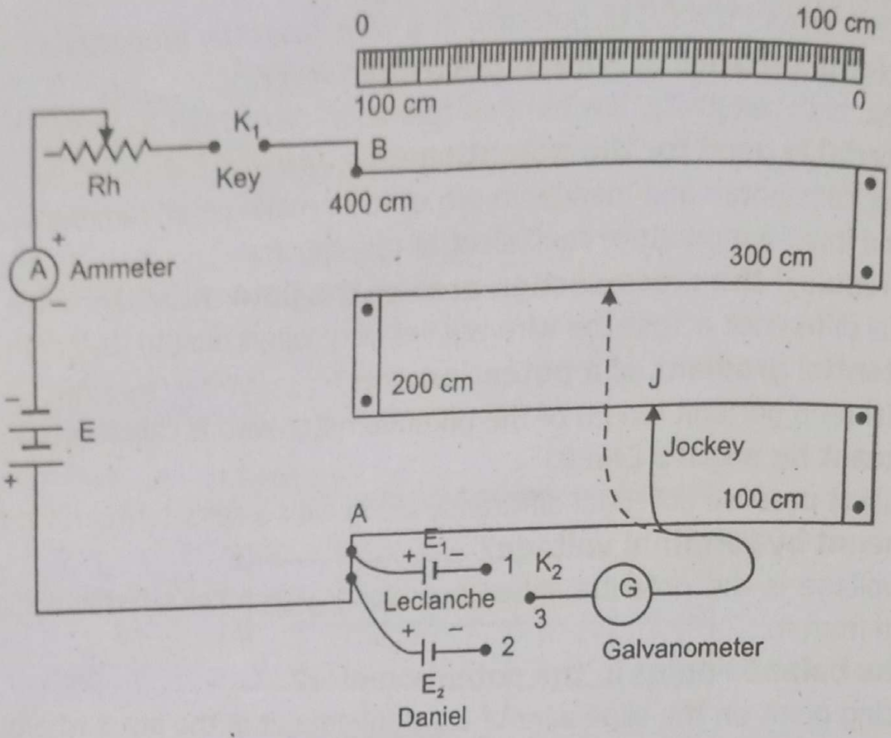
PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER

Q. **A student uses a potentiometer to compare the emf of a Leclanché cell (E_1) and a cell (E_2). The circuit includes a galvanometer and a jockey. The student records the balan lengths for each cell in six trials.**


0
100 cm
100 cm
0
Rh
K1
Key
B
400 cm
A
Ammeter
+
−
300 cm
200 cm
J
Jockey
100 cm
−
E
+
A
E1
+
−
1
K2
Leclanche
3
G
+
−
2
Galvanometer
E2
Daniel

(i) Complete the table.

S. No.	Balancing length l_1 of E_1 (cm)	Balancing length l_2 of E_2 (cm)	Ratio of EMFs $\frac{E_1}{E_2}=$
1	648.0	695.6	
2	613.4	673.5	
3	651.9	700.0	
4	720.4	777.2	
5	756.0	799.0	
6	1083.0	921.8	

(ii) Describe the procedure to obtain one pair of balancing lengths for the two cells.

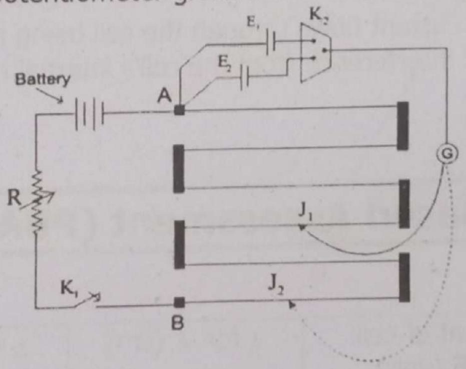
(iii) Explain why the potentiometer method is considered more accurate for measuring the EMF of a ce than using a voltmeter. (0

(iv) Explain how achieving a null point ensures accurate EMF measurement. (01)

(v) Suggest a modification to the setup for cells with very similar emf, and explain how it improves the comparison. (01)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

Consider the circuit arrangement of potentiometer given below used for comparison of emf's of two cells



(i) Complete the table. (2)

Observation	Emf of cell E (volt)	l_1 for E_1 (cm)	l_2 for E_2 (cm)	$\frac{E_1}{E_2}$ = ______
1	3	75	90	

(ii) Draw a circuit which can give continuously varying potential. (2)

(iii) What is the reason behind the null point? (1)

(iv) What are the applications of a potentiometer? (1)

Solution: Practical Based Assessment (PBA) Sample Paper- 1

(i)

S. No.	Balancing length l_1 of E1 (cm)	Balancing length l_2 of E2 (cm)	$\frac{E_1}{E_2} =$ ______
1	648.0	695.6	0.93
2	613.4	673.5	0.91
3	651.9	700.0	0.93
4	720.4	777.2	0.92
5	756.0	799.0	0.94
6	1083.0	921.8	1.17

(ii) Adjust rheostat for suitable current, close K1; connect Leclanché cell with correct opposition polarity
K2, move jockey to null deflection, record l_1
replace with Daniell cell (without changing rheostat), repeat for l_2.

(iii) The potentiometer measures EMF by comparing it with a standard cell at a point where no current flows through the cell being measured. This ensures that the cell's internal resistance does not affec the measurement, making it more accurate than a voltmeter, which draws current and introduces er due to internal resistance.

(iv) The null point ensures no current flows through the cell being measured, meaning the EMF is measured directly without interference from the cell's internal resistance.

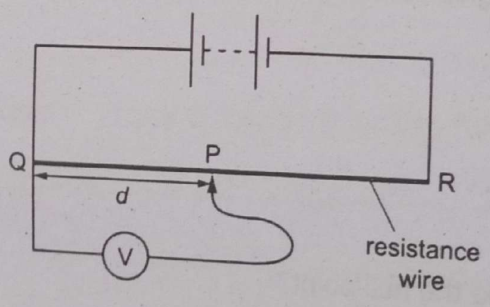
(v) Use a longer wire .
Use digital galvanometer

Solution: Practical Based Assessment (PBA) Sample Paper- 2

(i)

Observation	Emf of cell E (volt)	l_1 for E_1 (cm)	l_2 for E_2 (cm)	$\frac{E_1}{E_2} = \frac{l_1}{l_2}$
1	3	75	90	$\frac{E_1}{E_2} = \frac{75}{90} = 0.83$

(ii)



(iii) The null point is acquired because the cell's e.m.f. is balanced by the potential variation along a particular length of the connected potentiometer wire.

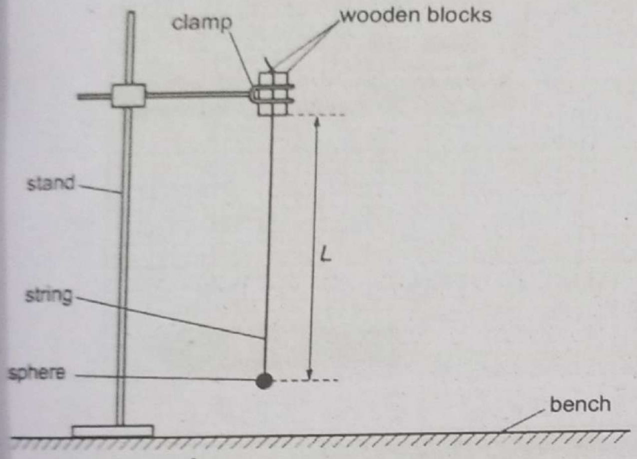
(iv) A potentiometer is used to
- Compare the emf of two cells
- Measure emf of a cell
- Determine the internal resistance of a cell

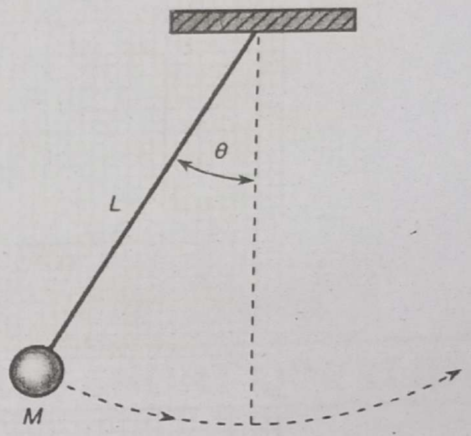
PRACTICAL 7

DETERMINE THE TIME PERIOD, FREQUENCY AND ANGULAR FREQUENCY OF SIMPLE PENDULUM BY VARYING ITS LENGTH.

Apparatus

Meter stick, Laboratory timer or stopwatch, Protractor, String, Pendulum bobs, Pendulum clamp, 1 sheet of Cartesian graph paper.



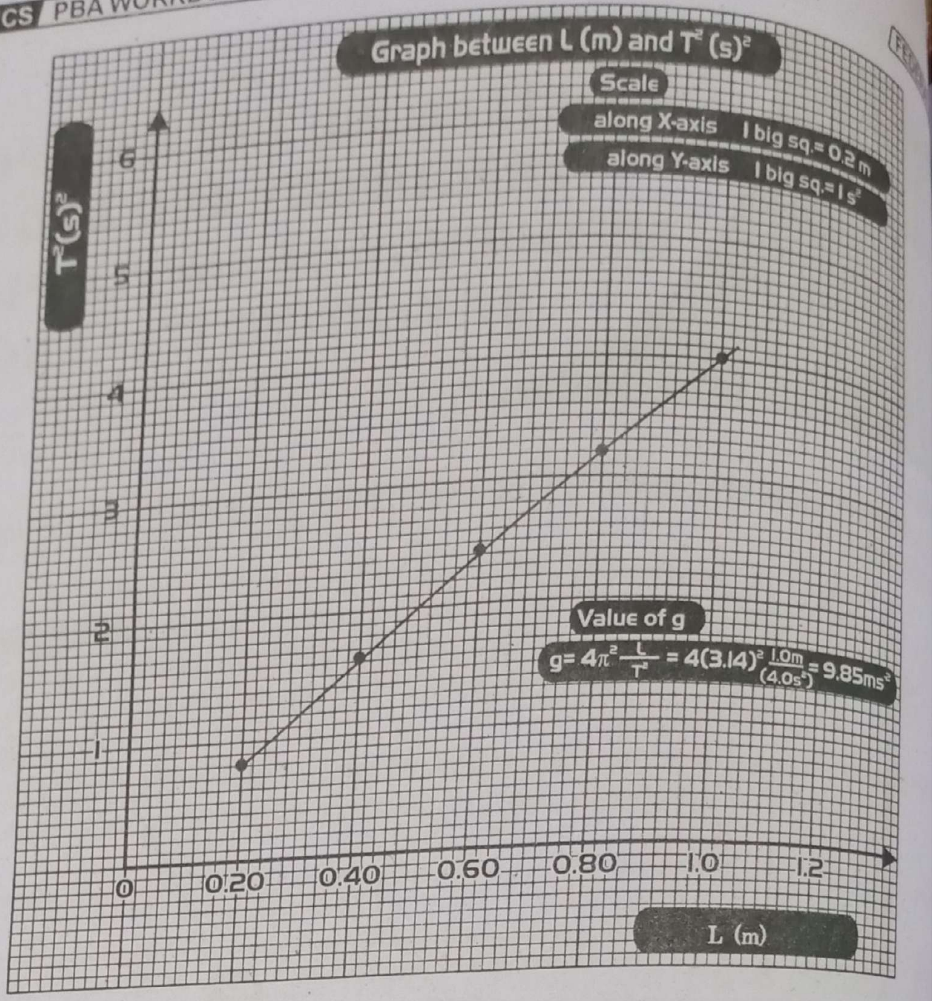


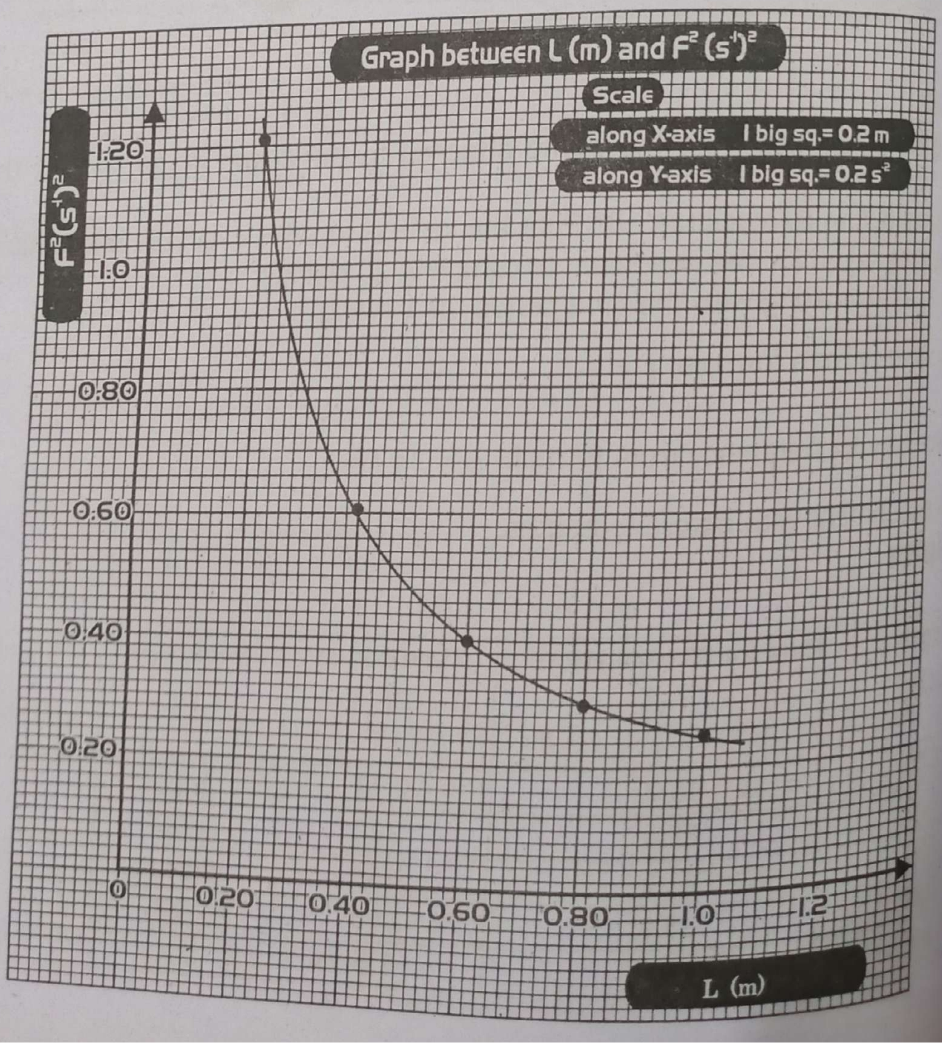
Procedures

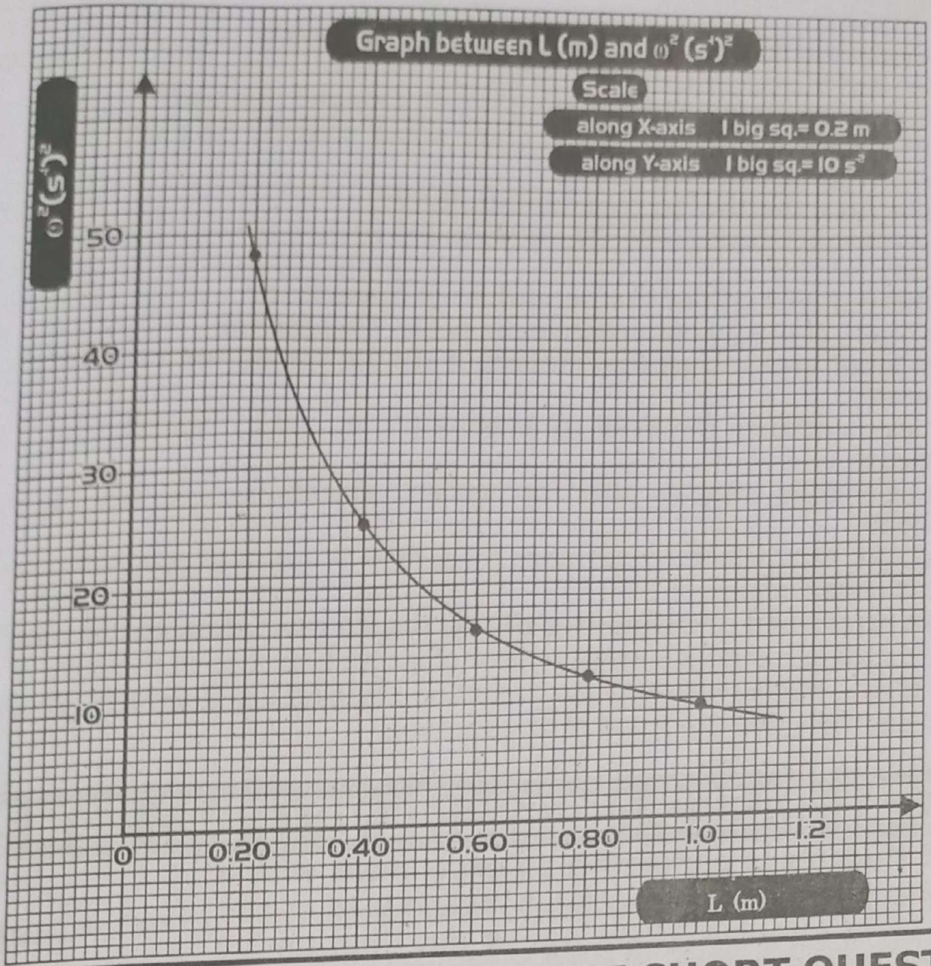
- Suspend the pendulum bob from the clamp attached to the clamp stand so that the pendulum length is 0.20m.
- Displace the pendulum by less than 10° from the vertical to set it in simple harmonic motion.
- Measure the time taken for the pendulum to complete 20 swings.
- Record this in a table along with the time period for 1 swing.
- Calculate frequency from formula $f = \frac{1}{T}$
- Also calculate angular frequency from formula $\omega = 2\pi f = \frac{2\pi}{T}$
- Repeat this experiment with different lengths.

Observations

Length $L(m)$	Time for 20 oscillations $t\,(s)$	Time period $T(s)$	frequency (Hz)	Angular frequency $\omega = \frac{2\pi}{T}\left(rad\,s^{-1}\right)$
0.20	18.0	0.90	1.11	6.9708
0.40	25.4	1.27	0.787	4.9423
0.60	31.1	1.56	0.641	4.0254
0.80	35.9	1.80	0.555	3.4854
1.00	40.0	2.0	0.5	3.14


Graph between L (m) and T² (s)²
Scale
along X-axis 1 big sq.= 0.2 m
along Y-axis 1 big sq.= 1 s²
T²(s)²
6
5
4
3
2
1
0
0.20
0.40
0.60
0.80
1.0
1.2
Value of g
g= 4π² L/T² = 4(3.14)² 1.0m/(4.0s²) = 9.85ms⁻²
L (m)


Graph between L (m) and F² (s⁻¹)²
Scale
along X-axis 1 big sq.= 0.2 m
along Y-axis 1 big sq.= 0.2 s⁻²
F²(s⁻¹)²
1.20
1.0
0.80
0.60
0.40
0.20
0
0.20
0.40
0.60
0.80
1.0
1.2
L (m)



POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

1. **Define simple pendulum.**

Ans. An ideal simple pendulum is defined as single isolated particle suspended by a weightless flexible and inextensible string with a friction-less support.

2. **What are the properties of an ideal simple pendulum?**

Ans. Following are the properties of ideal simple pendulum:

- Heavy point mass
- Inextensible string
- Weightless string
- Frictionless support

3. **What will happen to the motion of a pendulum if we place it at?**
(i) Equator (ii) Poles (iii) Earth's center

Ans. It becomes slow at the equator fast at poles and stops at the center of earth. Because 'g' is minimum at equator, maximum at poles and zero at the center of earth.

4. **What is SHM?**

Ans. It is the vibratory motion is which the acceleration of the body is directly proportional to the displacement from mean position and is always directed to mean position.

5. **How can you prove that time period of pendulum is independent of amplitude?**

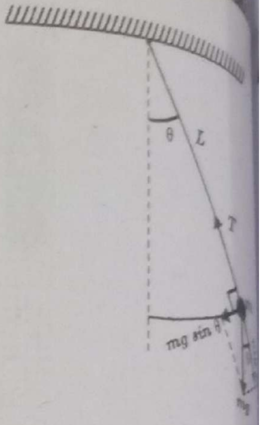
Ans. Calculate the time for 20 vibrations at different amplitude such as 10 cm, 15cm and 20cm. Dived that time to 20 which gives the time period of pendulum, and it will be a constant quantity which proves that it is independent of amplitude.

6. **Why the amplitude of the pendulum is kept small (2cm or about 5 cm)?**

Ans. The equations describing a swinging pendulum only accurately represent simple harmonic motion (SHM) when the amplitude is small. In SHM, the restoring force acting on the bob is directly proportional to its displacement from the equilibrium position. This relationship becomes progressively inaccurate as the amplitude increases.

7. **Can replace the thread by a metallic wire?**

Ans. No, because the wire is not flexible. By definition of simple pendulum, the string must be perfectly flexible. The thread is flexible but a metallic wire is not. That is why the wire can be used in place of thread.



8. What is restoring force (net force) acting on the bob?

Ans. If the air friction is neglected, restoring force on the bob = mg sinθ

9. What is net force on the bob, at equilibrium (mean) position?

Ans. Zero, since at mean position the weight of the bob is perfectly balanced by the tension (T) in the string

10. Can you replace the thread by a rubber band?

Ans. No, because it is not inextensible. By definition the string must be inextensible.

11. From where the length of the pendulum is measured?

Ans. From the centre of gravity of the bob to the point of suspension

12. what are input and output parameters in simple pendulum experiment?

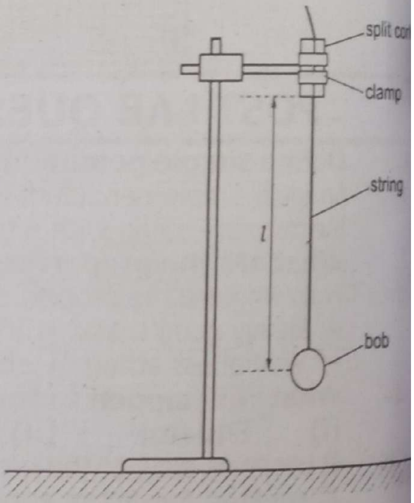
Ans. For a simple pendulum, the input parameters (m, θ, and L) influence the output parameter (T).

- Input parameters are often called independent variables because they can be varied independen each other.
- The output parameters, on the other hand, may be called dependent variables because their depend on the inputs.

13. What are errors and uncertainties of the simple pendulum experiment?

Ans: Systematic Errors: Inaccurate measurement of length L, friction at the point of suspension. Random Errors: Human reaction time in starting/stopping the stopwatch, parallax error in measuri length, determining the exact end of an oscillation.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER-



Q. A group of students is performing an experiment with a simple pendulum, varying the length L between 0.25 m and 1.25 m in 0.25 m intervals. They record the time for 20 swings at each length to find T, f, and ω, and analyze the data to verify theoretical relationships under standard gravity.

(i) Describe the steps a student would take to accurately determine the length L of the pendulum (1)

____

____

____

(ii) Complete the table. (2)

Length $L(m)$	Time for 20 oscillations $t(s)$	Time period $T(s)$	frequency (Hz)	Angular frequenc $\omega(rad\,s^{-1})$
0.25	20.0	1.0		
0.50	28.3	1.415		
0.75	34.6	1.73		
1.00	40.0	2.0		
1.25	44.7	2.235		

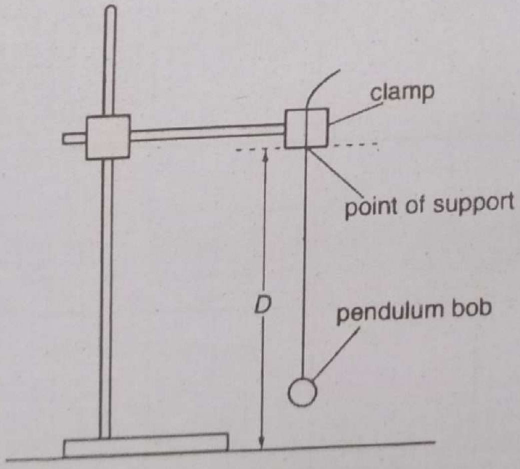
(iii) To determine g from the data, a graph of ω^2 against L^{-1} should be plotted. Sketch the expected sha of this graph and state the physical quantity that the gradient represents. (3)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

A student investigates the period of a simple pendulum. The period T is the time taken for ne complete oscillation of the pendulum.

he sets up the pendulum with its point of support a fixed height above the surface of the bench. She does ot change this height, or the position of the clamp during the investigation.

scale diagram of her experimental set-up is shown in Fig.



(i) She adjusts the length of the thread until the height h of the centre of the bob above the bench is 15.0cm. She gives the ball a small sideways displacement and releases it so that it oscillates. She records the time for 20 oscillations in the table in Fig.

She repeats the procedure for heights h of 20.0cm, 25.0cm, 30.0cm and 40.0cm.

She uses her results to calculate the period T for one oscillation and T^2 for each set of readings.

a) Complete the table. (2

H (cm)	Time for 20 oscillations t (s)	Time period T (s)	T^2 (s^2)
15.0	22.8		
20.0	20.8	1.04	1.08
25.0	18.8		0.88
30.0	16.6	0.83	
40.0	10.6		0.28

b) Explain why measuring the time for 20 oscillations, rather than for 1 oscillation, gives a more accurate value for T. (1

(iii) (a) On Fig. , plot a graph of T^2 / s^2 on the y-axis against h/ cm on the x-axis. Start your axes from the origin (0,0). Draw the straight line of best fit. (2)

(b) Calculate the gradient m of your line. Show your working and indicate on your graph the values you use to calculate the gradient.

m = ... s^2 / cm [1]

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 3

A student performs an experiment to determine the relationship between the length L of a mple pendulum and its time period T. They record the time t for 20 complete oscillations for ifferent lengths. The setup used is a metal bob suspended by a string from a clamp stand.

Complete the table (2)

Length L(m)	Time for 20 oscillations t(s)	Time period T(s)	Angular frequency ω
0.30	21.6		

Describe the expected trend in the time period T as the length L increases, and explain this trend using the formula for the period of a simple pendulum. (1)

Suggest one reason why it is more accurate to measure the time taken for 20 oscillations rather than for a single oscillation. (1)

The students notice that the product $\omega\sqrt{L}$ is almost constant. Explain why this is expected theoretically and calculate its theoretical value using g = 9.81 m s^{-2}. (2)

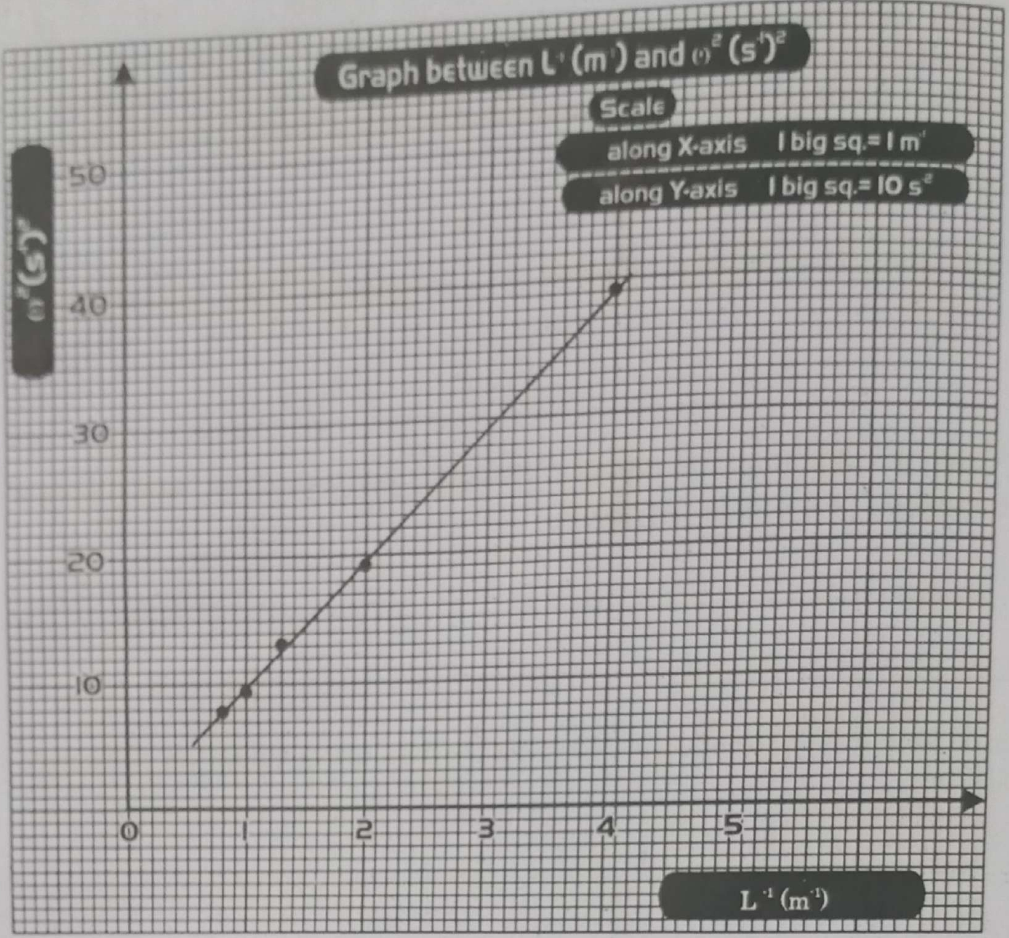
Solution: Practical Based Assessment (PBA) Sample Paper- 1

Measure the length of the string from the point of support to the top of the bob.
Add the radius of the pendulum bob using vernier calipers

(ii) Complete the table.

Length $L(m)$	Time for 20 oscillations $t(s)$	Time period $T(s)$	frequency (Hz)	Angular frequency $\omega(rad\,s^{-1})$
0.25	20.0	1.0	1.0	6.28
0.50	28.3	1.415	0.707	4.44
0.75	34.6	1.73	0.578	3.63
1.00	40.0	2.0	0.5	3.14
1.25	44.7	2.235	0.447	2.80

(iii)



Sketch should be a straight line passing through the origin.
The gradient represents the acceleration of free fall

$$\omega = \sqrt{\frac{g}{L}} \qquad \omega^2 = \frac{g}{L}$$

Solution: Practical Based Assessment (PBA) Sample Paper- 3

(i)

Length L(m)	Time for 20 oscillations t(s)	Time period $T = \frac{t}{20}$ (s)	Angular frequency $\omega = \frac{2\pi}{T}$ $(rad\, s^{-1})$
0.30	21.6	1.08	5.82

(ii) As L increases, T increases (non-linearly, or sqrt relationship).

Explanation: $T = 2\pi\sqrt{\frac{L}{g}}$, T is proportional to $\sqrt{L}$, so longer length means longer period as the bob travels a greater arc distance but with similar gravitational restoring force.

(iii) Because reaction time becomes a smaller proportion of the total measured time. Timing more oscillations reduces fractional/percentage error

(iv) Theory: $\omega = \sqrt{\frac{g}{L}}$ $\Rightarrow \omega\sqrt{L} = \sqrt{g} = constant$

$$\omega\sqrt{L} = \sqrt{g} = \sqrt{9.8} = 3.13 \ rad\, s^{-1} m^{\frac{1}{2}}$$

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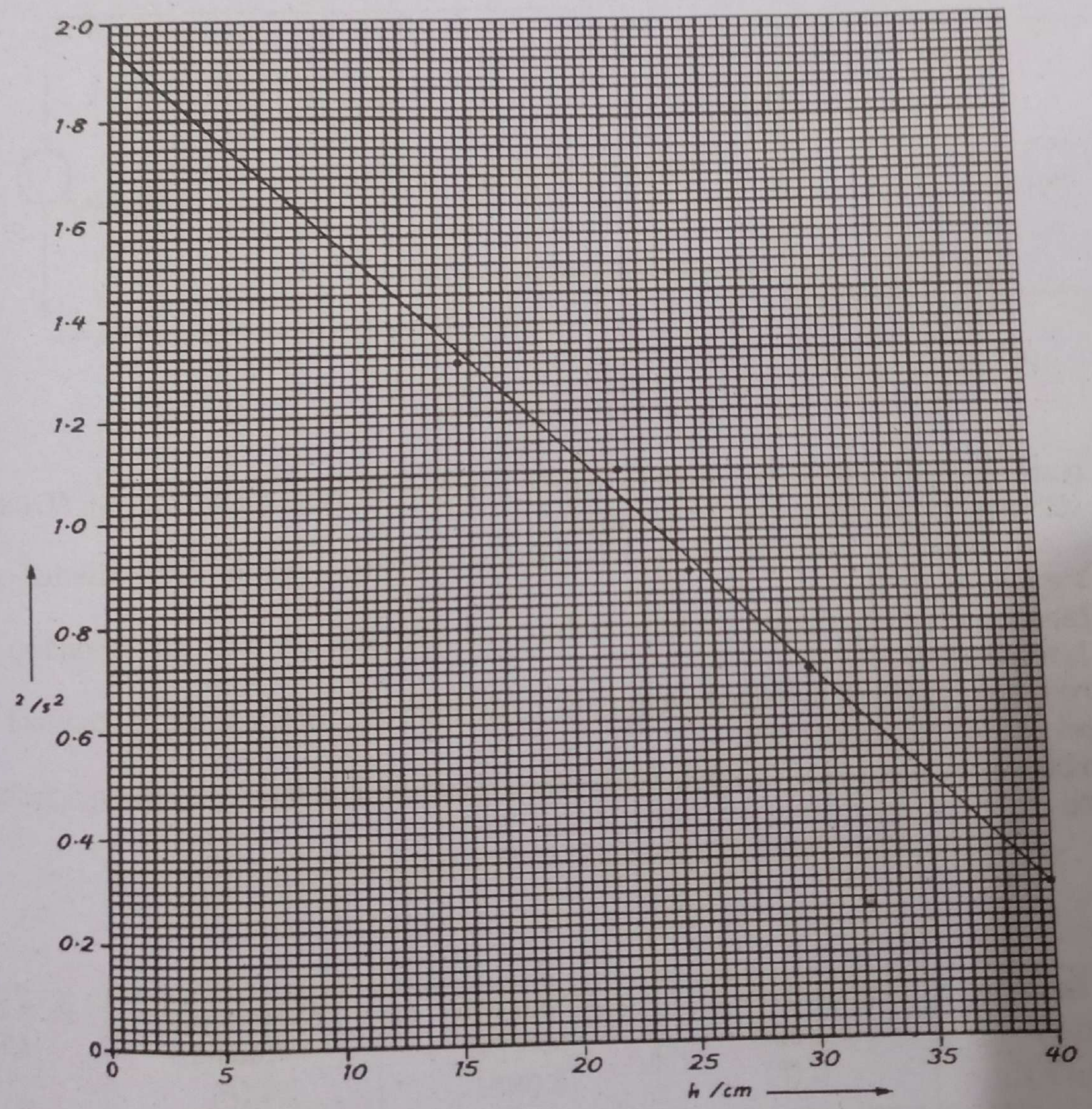
Solution: Practical Based Assessment (PBA) Sample Paper- 2

(i) (a)

h/cm	Time for 20 oscillations t/s	Time period T/s	T^2/s^2
15.0	22.8	1.14	1.30
20.0	20.8	1.04	1.08
25.0	18.8	0.94	0.88
30.0	16.6	0.83	0.69
40.0	10.6	0.53	0.28

(b) This reduce the effect of error in starting and stopping the stop watch

(iii) (a)



(b) Calculate the gradient m of your line. Show your working and indicate on your graph the values you use to calculate the gradient.

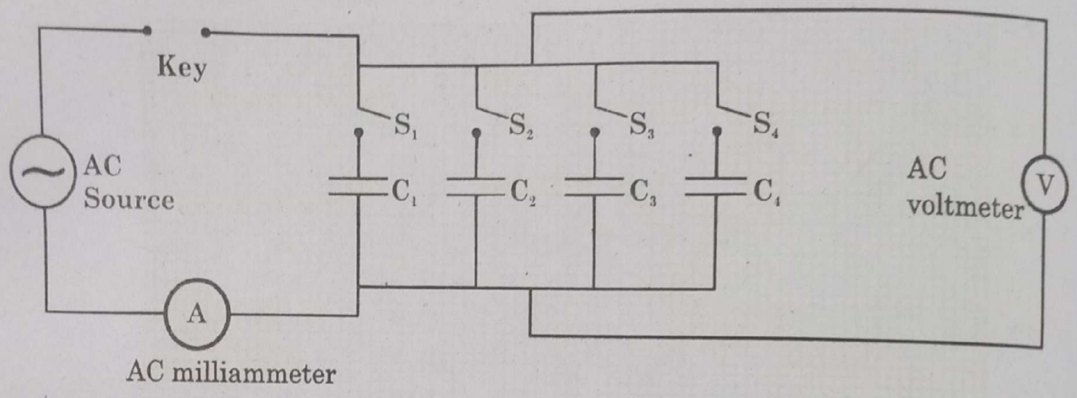
$$m=\frac{1.95-0.28}{0-40}=-0.4175\,s^2/cm$$

PRACTICAL 08

DETERMINE THE RELATION BETWEEN CURRENT AND CAPACITANCE FOR DIFFERENT COMBINATIONS OF CAPACITORS IN AC CIRCUITS.

Apparatus:

AC power supply, AC milliammeter, Key , Capacitors , Switches , AC voltmeter ,



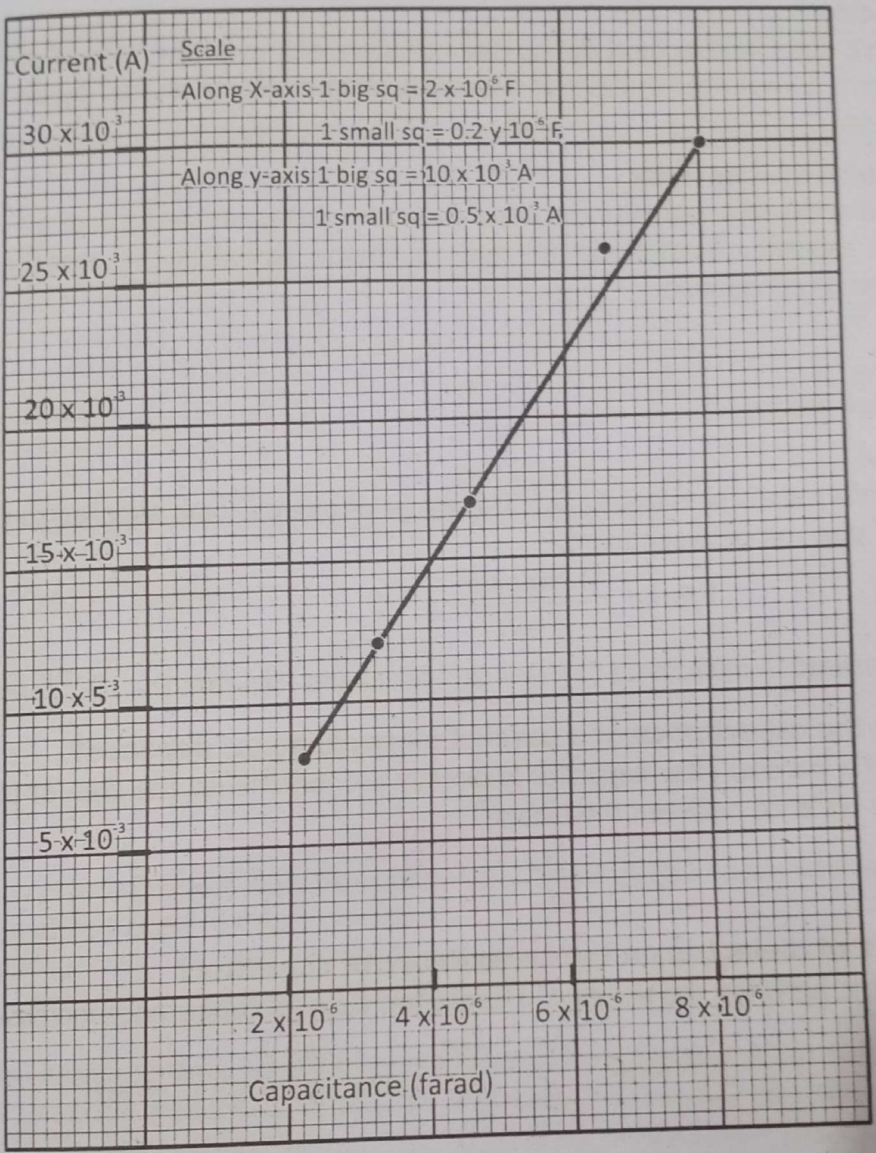
Procedure:

1. Connect a given capacitor say C_1 in series to a milli ammeter through a key K to an AC mains. Also join an AC voltmeter in parallel to a given capacitor C.
2. Plug key K and note the current I_1 from milliammeter flowing through first inserted capacitor "C_1". Find the ratio of I_1/C_1 .
3. Plug other capacitors C_2 , C_3, C_4 turn by turn in the circuit and note down the corresponding currents I_2, I_3 and I_4 respectively.
4. Calculate the ratio of currents to capacitances I_2/C_2, I_2/C_3 and I_3/C_3 which must be constant for all the capacitors used in the experiment.
5. Plot a graph between capacitance 'C' along x-axis and the current I along y-axis. This graph should be a straight line

Table:

No of obs.	Capacitance in circuit C (μF)	Capacitance in circuit C (F)	AC ammeter reading I (mA)	AC ammeter reading I (A)	I/C = const A/F
1	2.2	2.2×10^{-6}	8.2	8.2×10^{-3}	3727 A/F
2	3.3	3.3×10^{-6}	12.4	12.4×10^{-3}	3757 A/F
3	4.7	4.7×10^{-6}	17.7	17.7×10^{-3}	3765 A/F
4	22+3.3=5.5	5.5×10^{-6}	20.7	20.7×10^{-3}	3763 A/F
5	2.2+4.7=6.9	6.9×10^{-6}	26	26×10^{-3}	3768 A/F
6	3.3+4.7=8	8×10^{-6}	30	30×10^{-3}	3727 A/F

raph:



nference:

AS I/C = constant, so is directly proportional to the capacitance in an AC circuit.

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

1. What is a capacitor?

Ans: A capacitor is a two-terminal electrical device that can store energy in the form of an electric charg In its simplest form, a capacitor consists of two conducting plates separated by an insulating mat called the dielectric.

2. Define capacitance and its units.

Ans: Capacitance is the ability of a capacitor to collect and store energy in the form of an electrical charg Capacitance of a capacitor is equal to the ratio of charge stored in the capacitor to the poten difference between its conductors.

$$C = \frac{Q}{V}$$

Units of capacitance are Farad

3. Define one farad.

Ans: The capacitance of a capacitor is one Farad, if a charge of one coulomb supplied to one of its plats produces a P.D of one volt between them.

$$1\,farad = \frac{1\,coulomb}{1\,volt}$$

It is usually measured in microfarad (μf) = 10^{-6} farad and Pico-farad = 10^{-12} farad

4. On what factors the capacitance of a parallel plate capacitor depends?

Ans: The capacitance of a parallel after capacitor is directly proportional to the area of plates and invers proportional to the distance between the plates.

$$C_{vaccam} = \frac{A\varepsilon_o}{d}$$

5. What is the effect of dielectric on the capacitance of capacitor?

Ans: By placing a dielectric between the plates of a capacitor, then its capacitance increases.

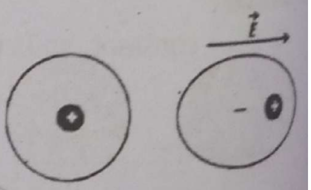
$$C_{medium} = \frac{A\varepsilon}{d} = \frac{A\varepsilon\varepsilon_r}{d} = \varepsilon_r\left(\frac{A\varepsilon_o}{d}\right) = \varepsilon_r\left(C_{vaccam}\right)$$

6. What is a dielectric?

Ans: a dielectric (or dielectric medium) is an electrical insulator that can be polarized by an applied electric field.

7. What is the electric polarization of dielectric?

Ans: slight relative shift of positive and negative electric charge in opposite directions within an insulator, or dielectric, induced by an external electric field is called electric polarization.



8. How does polarization affect capacitance?

Ans: Polarization increases the effective capacitance of a capacitor because it reduces the net electric field between the capacitor plates, allowing more charge to be stored for a given voltage.

9. Define dielectric constant?

Ans: The ratio of the capacitance of a parallel plate capacitor with an insulating substance as medium between the plates to its capacitance with vacuum (or air) as medium between them.

$$\varepsilon_r = \frac{\varepsilon}{\varepsilon_o}$$

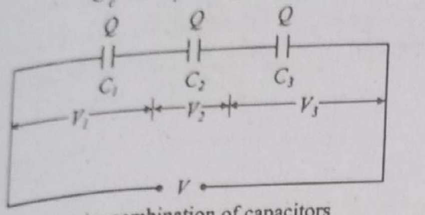
10. **What are the applications of capacitors in daily life?**

Ans: Capacitors are used in electronic devices such as time delaying circuits, flip flop circuits, camera flashgun and in radio turning circuits.

11. **What is the effect on capacitance when some capacitors are joined in series and in parallel?**

Ans: Series Combination of Capacitors

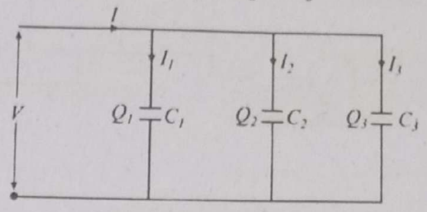
$$\frac{1}{C_e}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}$$



series combination of capacitors

Parallel Combination of Capacitors

$$C_e=C_1+C_2+C_3$$



parallel combination of capacitors

12. **Show that reactance is measured in Ohm for capacitors**

Ans:

$$X_C=\frac{1}{2\pi fC} \qquad \therefore f=\frac{1}{T}$$

$$X_C=\frac{Second}{Farad}=\frac{Second}{\frac{Coulomb}{volt}}$$

$$X_C=\frac{second\times Volt}{Amphere\times second}=\frac{Volt}{Amphere}=ohm$$

13. **Explain why connecting a pure resistor in series with the capacitor is necessary if the circuit is used to power a component**

Ans: A pure capacitor does not dissipate power/energy.

A resistor is needed to limit the current or to dissipate energy for a load.

14. **Students investigate how total current varies when two capacitors of 4 μF and 6 μF are connected in series and parallel to a 12 V (rms), 100 Hz AC source.**
(a) Calculate the total capacitance for: (i) Series connection (ii) parallel connection.
(b) For the series combination, find the rms current.

Ans:

(a) (i) $\frac{1}{C_{series,eq}}=\frac{1}{4\mu F}+\frac{1}{6\mu F}$ $\qquad C_{series,eq}=2.4\mu F$

(ii) $C_{parallel,eq}=4\mu F+6\mu F=10\mu F$

(b) $\omega=2\pi f=2\pi(100Hz)=628\,rad\,s^{-1}$

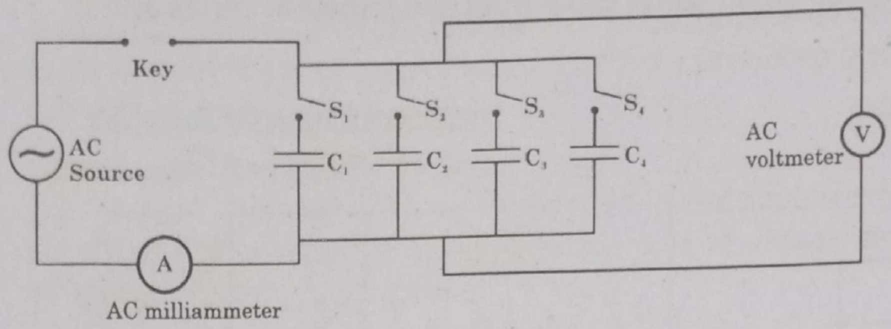
$$I_{rms}=\frac{V_{rms}}{X_C}=V\omega C=(12)(628)(2.4\times10^{-6})=0.018\,A=18\,mA$$

15. **Two parallel 2μF capacitor is connected in series with a 100 Ω resistor; describe qualitatively how the power dissipated in the resistor varies with frequency.**

Ans: At higher frequency, X_C decreases, that's mean total impedance Z decreases. So current increases, hence more power dissipated across resistor (since $P=IR^2$).

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER

Q. An AC circuit is powered by a 240 V, 50 Hz source and contains different capacitors co in parallel.


Key
AC Source
S_1
S_2
S_3
S_4
C_1
C_2
C_3
C_4
AC voltmeter
V
A
AC milliammeter

	Current (mA)	Capac (μ
1	3	0
2	9	2
3	14	3
4	21	4

(i) Plot a graph of these results.

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(ii) From graph comment on the trend observed. Is the relationship linear? If so, what does this indicate about the dependency of current on capacitance? (01)

(iii) If the AC source frequency were doubled, describe how the current readings in your experiment would change. Justify your answer using the concept of capacitive reactance. (01)

(iv) calculate the capacitive reactance for capacitance in observation 4 (02)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

Q. If you are given two capacitors, $C_1 = 6\ \mu F$ and $C_2 = 12\ \mu F$ and by a 240 V, 50 Hz AC source.

(i) Draw a circuit to study current-to-capacitance ratio, where capacitors are connected in parallel combination. (1)

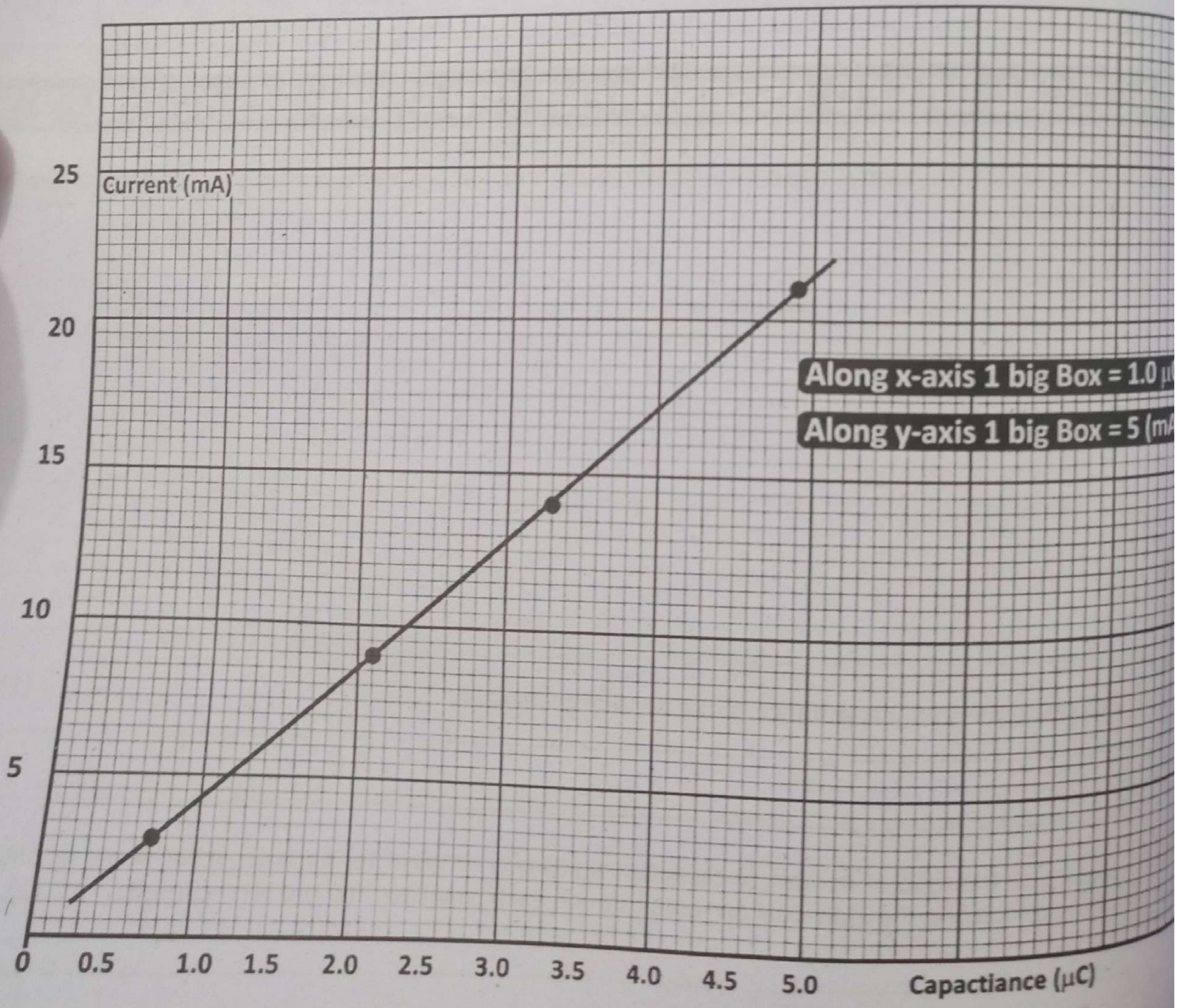
(ii) Determine the total capacitance of the parallel combination (1)

(iii) Show that the ratio of current to capacitance remains constant for each capacitor in the circuit. Verify this by calculating the individual currents through each capacitor and the total current. (2)

(iv) If a third capacitor, C_3 = 18 μF, is added in parallel, calculate the new total capacitance ar current. Does the current to capacitance ratio remain the same? Justify your answer with calcula

Solution: Practical Based Assessment (PBA) Sample Paper- 1

(i)



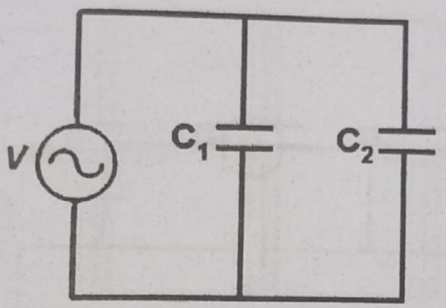
(ii) The plot of I against C shows a linear increase, indicating that the current is directly propo capacitance for a constant frequency and voltage.

(iii) Doubling the frequency doubles ω, thereby halving X_C for a given capacitance. This would res in a higher current, as $I = \frac{V}{X_C} = V\omega C$

(iv) $$X_C = \frac{1}{\omega C} = \frac{1}{2\pi fC} = \frac{1}{2\pi(50)\left(4.9\times10^{-6}\right)} = 649.9\Omega$$

Solution: Practical Based Assessment (PBA) Sample Paper- 2

(i)



(ii) $C_e = C_1 + C_2 = 6\mu F + 12\mu F = 18\mu F$

(iii) For $C_1 = 6\mu F$

$$I_1 = V(2\pi f)C_1 \qquad \therefore I = \frac{V}{X_c} = V\omega C = V(2\pi f)C$$

$$I_1 = (240)(2\pi\times50)\left(6\times10^{-6}\right) = 0.452A$$

For $C_2 = 12\mu F$

$$I_2 = V(2\pi f)C_2 = (240)(2\pi\times50)\left(12\times10^{-6}\right) = 0.904A$$

Current-to-capacitance ratios for C_1 $\quad \frac{I_1}{C_1} = \frac{0.452A}{6\times10^{-6}F} = 75.3\,AF^{-1}$

Current-to-capacitance ratios for C_2 $\quad \frac{I_2}{C_2} = \frac{0.904A}{12\times10^{-6}F} = 75.3\,AF^{-1}$

Thus, the current-to-capacitance ratio remains constant for both capacitors.

(iv) $C_e = C_1 + C_2 + C_3 = 6\mu F + 12\mu F + 18\mu F = 36\mu F$

$$I_{total} = V(2\pi f)C_{eq} = (240)(2\pi\times50)\left(36\times10^{-6}\right) = 2.71A$$

The new ratio for the entire circuit $\quad \frac{I_{total}}{C_{eq}} = \frac{2.71A}{36\times10^{-6}F} = 75.3\,AF^{-1}$

The current-to-capacitance ratio remains constant even with the additional capacitor.

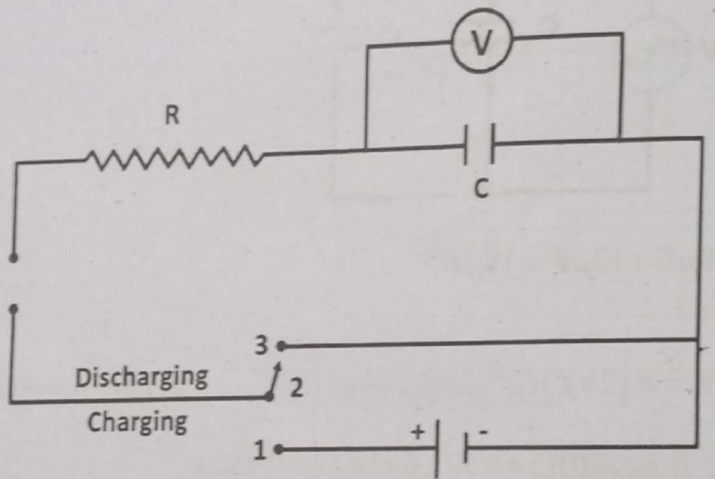
PRACTICAL 9

STUDY THE CHARGING AND DISCHARGING OF A CAPACITOR THROUGH A RESISTOR AND CALCULATE THE TIME CONSTANT.

Apparatus:

Capacitor, Digital stop watch, Two way key, Battery, Resistance, Digital voltmeter

Diagram



Procedure:

1. Connect the circuit according to the circuit diagram. Keys K1 and K2 must be kept open while connecting the circuit.

I. Procedure for charging the capacitor:

a. Adjust the variable resistor to some high value and then close the key k1 while K2 must be ke
b. Open and at the same time start the stop watch to note the voltage say after every 10 secon the capacitor is fully charged
c. Plot a graph of time 'T' along x-axis and the corresponding current "I" along y-axis

II. Procedure for discharging the capacitor:

a. Reset the stop watch to zero reading.
b. Take out the key so that the power supply is cut off from the circuit.
c. The capacitor starts discharging though the resistance and current starts to decrease.
d. Note the voltage after every 10 seconds till the capacitor is fully discharged.

Observations:

Capacitance = C = 2500 F

Capacitance = R = 3.5 K

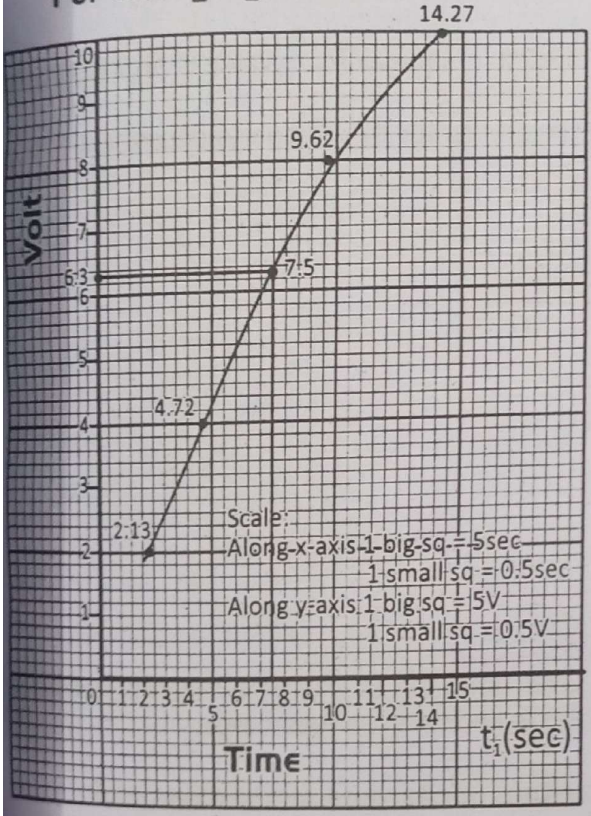
ble:

For charging			For discharging		
No. of Obs.	Time t (sec)	Voltage across the capacitor V (volt)	No. of Obs.	Time t (sec)	Voltage across the capacitor V (volt)
1.	2.13	2	1	2.78	8
2.	4.72	4	2	5.22	6
3.	7.29	6	3	8.78	4
4.	9.64	8	4	16.19	2
5.	14.27	10	5	41.15	0

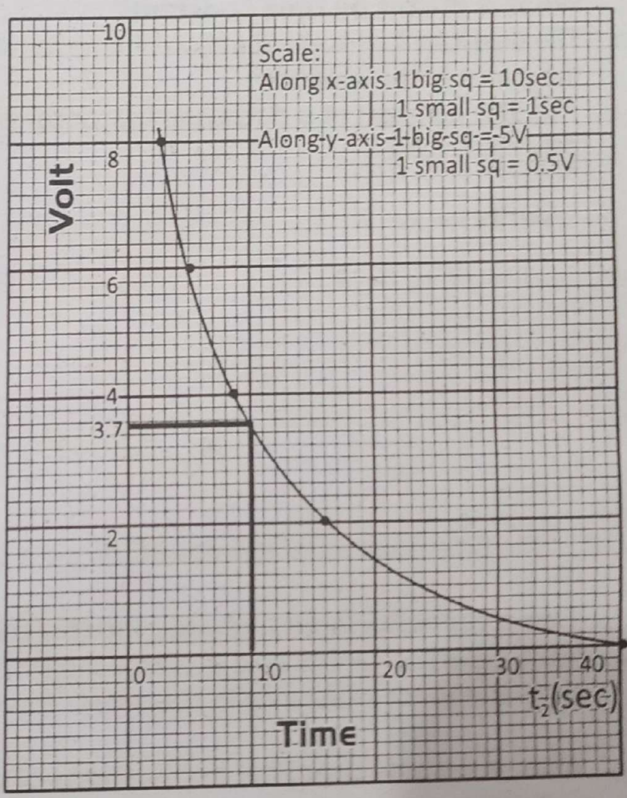
lculations:

Time constant from graph = t_1 = 8.75s

For Charging



For Discharging



lculations:

ne constant from graph = t_1 = 7.5s

ne constant from graph = t_2 = 10s

an value of time constant = t = 8.75s

m the values of R and C, t = R x C = 3.5k x 2500mf = 8.75sec

ST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

How does a capacitor charge and discharge?

: A capacitor charges by storing electrical energy in the form of an electric field between two c plates. When a voltage is applied to the capacitor, one plate becomes positively charged and becomes negatively charged.

The discharging of a capacitor is the process through which stored charge within the ca released, when the voltage is removed.

What factors affect the charging and discharging of a capacitor?

: The rate of charging and discharging of a capacitor is affected by the capacitance (siz capacitor, the voltage applied, and the resistance in the circuit.

A higher capacitance or voltage will result in a faster charging and discharging time, while resistance will slow down the process.

How long does it take for a capacitor to charge and discharge?

: The time it takes for a capacitor to charge and discharge depends on the capacitance and res the circuit. A larger capacitor or resistance will result in a longer charging and dischar However, it typically takes only a few milliseconds for a capacitor to charge or discharge.

What is meant by time constant?

: The time constant is the duration of time for which 63.2% of its maximum value charge is dep the plates of the capacitor. OR

The time constant of a discharging capacitor is the time taken for the charge to decrease to 37 maximum value

Verify $t = RC$ **?**

: $V = IR = \left(\frac{Q}{t}\right)R \quad \Rightarrow \quad R = \frac{V \times t}{Q}$

$C = \frac{Q}{V}$

$$RC = \frac{V \times t}{Q} \times \frac{Q}{V} = t$$

The time constant of a series RC circuit is t=RC.

Can a capacitor hold a charge indefinitely?

: No, a capacitor cannot hold a charge indefinitely. Over time, the charge on a capacitor will slo away due to the resistance in the circuit. This process is known as self-discharge.

What are some practical applications of capacitors in charging and discharging?

: Capacitors are commonly used in electronic devices to store and release electrical energy. Th used

- in flash cameras to provide a quick burst of light
- in power supplies to smooth out voltage fluctuations
- in audio equipment to filter out unwanted noise

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RACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

Students are investigating the charging and discharging behavior of a capacitor throug 10Ω resistor, with the capacitor initially uncharged and connected to a 10V DC source.

For charging			For discharging		
No. of Obs.	Time t (sec)	Voltage across the capacitor V (volt)	No. of Obs.	Time t (sec)	Voltage across the capacitor V (volt)
1.	1.50	2.3	1	1.20	8.2
2.	3.20	4.7	2	3.00	6.1
3.	5.10	6.3	3	5.50	4.5
4.	7.40	8.1	4	8.00	2.7
5.	10.0	9	5	12.00	0.8

(i) Plot the graph of voltage V across the capacitor versus time t for the discharging process. (02

Calculate time constant from graph. (01)

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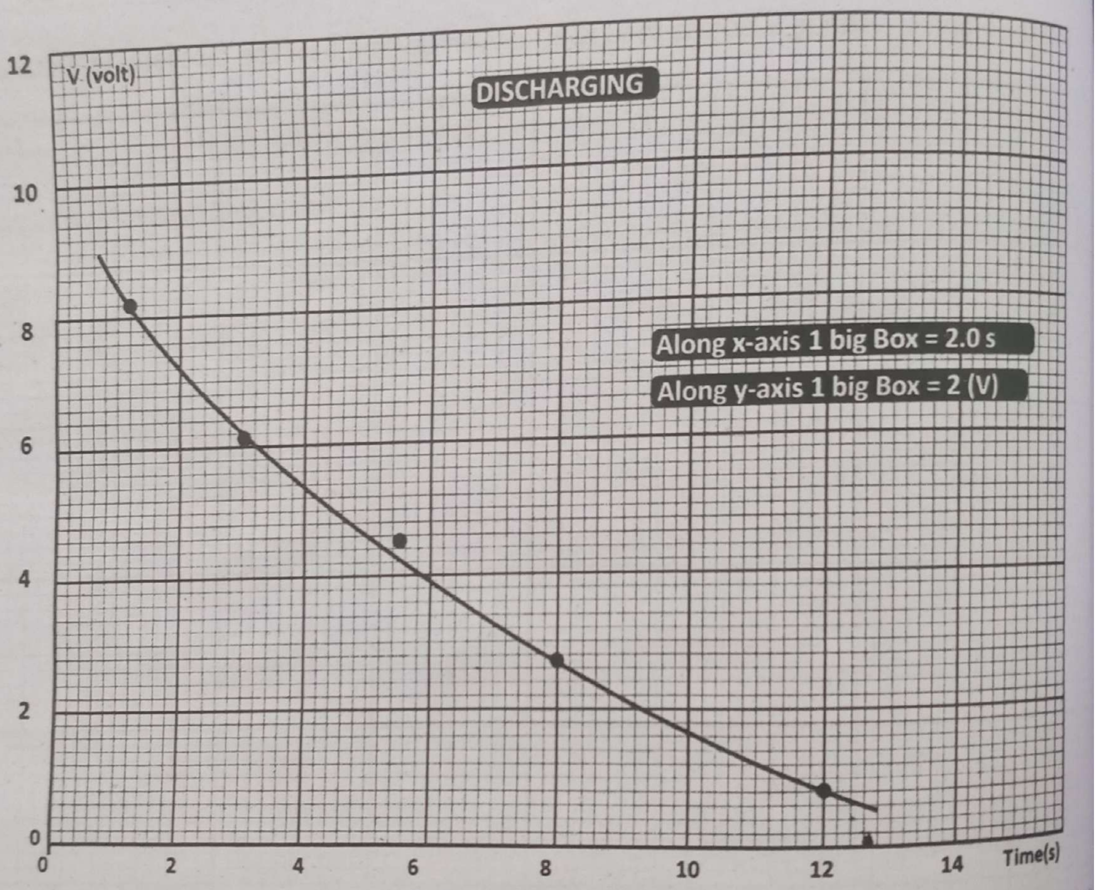
(iii) Describe how the time constant τ would change if the resistance R were increased to 20Ω.

(iv) State and explain the trend in the power dissipated across the resistor R during the discharging process.

Solution: Practical Based Assessment (PBA) Sample Paper- 1

(i)



(ii) The time constant $\tau = RC$ is found by locating the time when the voltage reaches 63% of value for charging or falls to 37% for discharging. From the graphs, estimated value is $\tau \approx 3.2s$.

(iii) Increasing R to 20Ω increases τ, leading to slower charging/discharging

(iv) The power dissipated decreases (from a maximum to zero).

Explanation: $$P_{dissipated} = \frac{V^2}{R}$$

As the capacitor discharges, the voltage V across the resistor and capacitor decreases exponenti with time. Since P is proportional to V^2, the power decreases exponentially.

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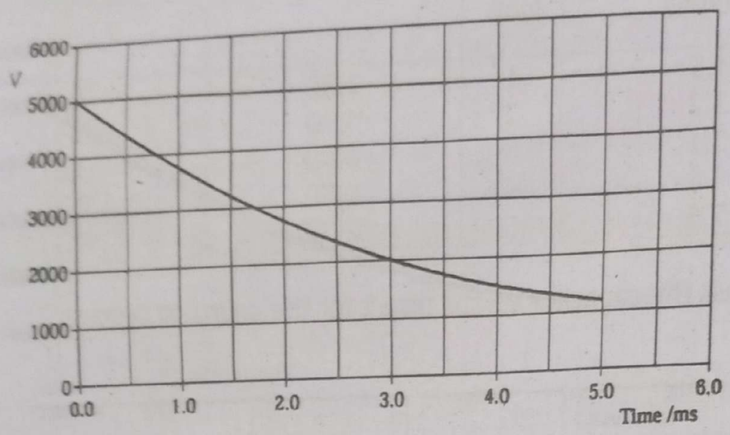
PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

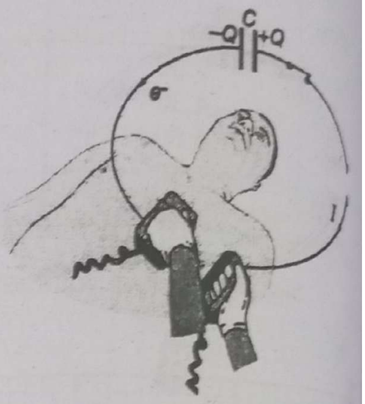
Q. **Students are investigating the charging and discharging behavior of a capacitor through a 15Ω resistor, with the capacitor initially uncharged and connected to a 8V DC source.**

For charging			**For discharging**		
No. of Obs.	Time t (sec)	Voltage across the capacitor V (volt)	No. of Obs.	Time t (sec)	Voltage across the capacitor V (volt)
1.	2.00	1.5	1	1.80	7.1
2.	4.50	3.2	2	4.20	5.5
3.	6.80	5.1	3	6.80	3.8
4.	9.50	6.6	4	9.50	2.4
5.	12.20	7.5	5	14.00	0.5

(i) Plot the graph of voltage V across the capacitor versus time t for the charging process. (02)

To restore a regular heart rhythm to a patient in an emergency, paramedics can use a mac called a defibrillator. The defibrillator uses a capacitor to store energy at a voltage of se thousand volts. Conducting 'paddles' are placed on either side of the patient's chest, and a pulse of current flows between them when the capacitor is discharged.
The graph below shows how voltage varies with time as the capacitor's discharged across a circuit that has a resistance equivalent to that of the patient's chest.



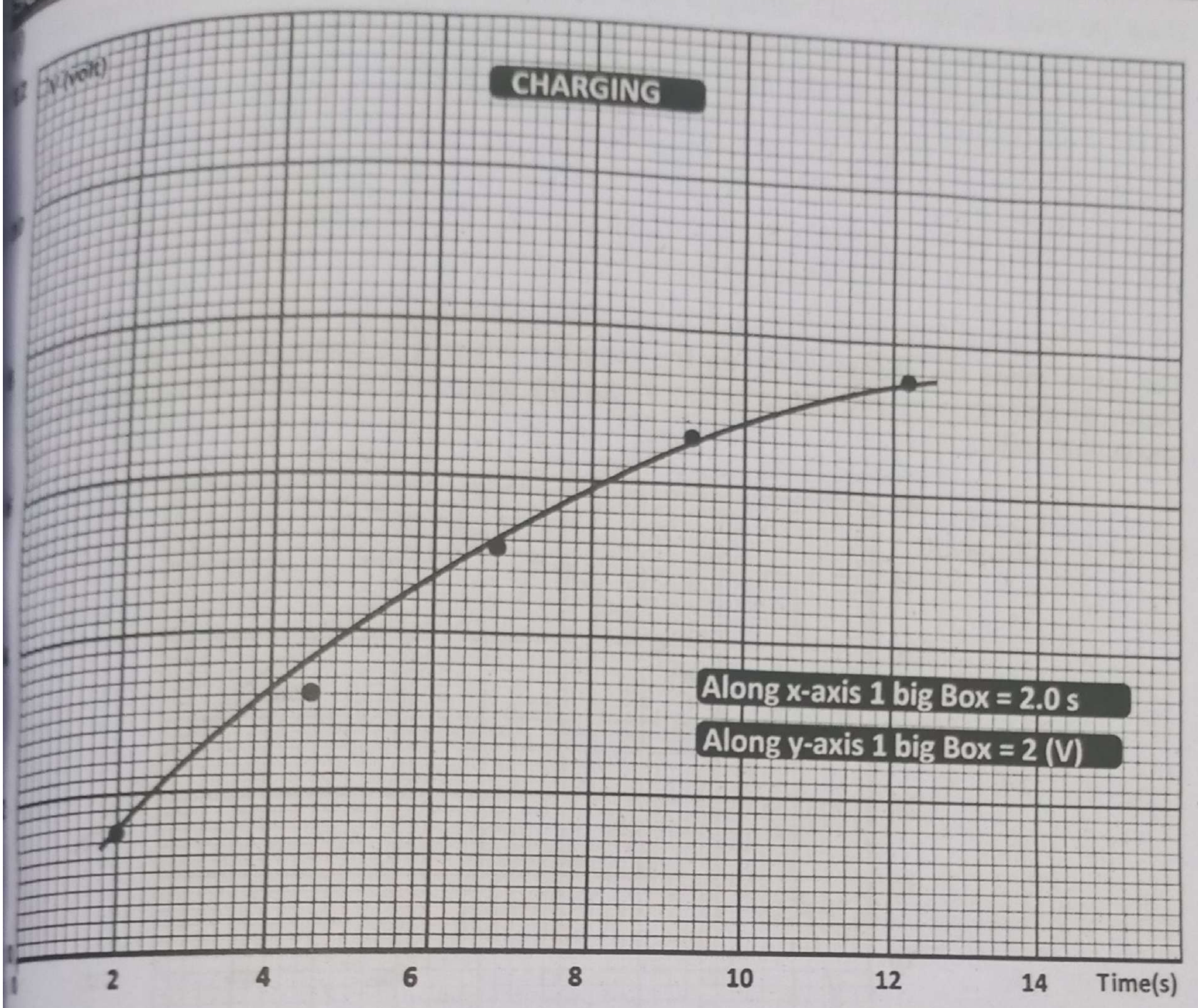


se the graph to find the time constant for the circuit. (02)

ne total resistance of the circuit, including the paddles and chest, is 47 Ω. Calculate the capacitance
e capacitor. (01)

ne student replaces the capacitor with a larger one. Predict and explain how this affects the current
nd the phase difference between current and voltage. (01)

Solution: Practical Based Assessment (PBA) Sample Paper- 2



The time constant τ is the time it takes for the voltage to drop to about 37% of its initial value.

$0.37\%\ of\ 5000V$

$$\frac{37}{100}(5000V)=1850V$$

Based on the graph, it seems that the voltage 1850 V reaches approximately around τ =3.2 ms. Hence, the time constant τ is approximately 3.2ms.

$$C=\frac{\tau}{R}=\frac{3.2\times10^{-3}s}{47\Omega}=0.068\times10^{-3}\approx 68\mu F$$

Increasing C, increases τ and decreases reactance X_C

$$\downarrow X_C=\frac{1}{2\pi f(C\uparrow)}$$

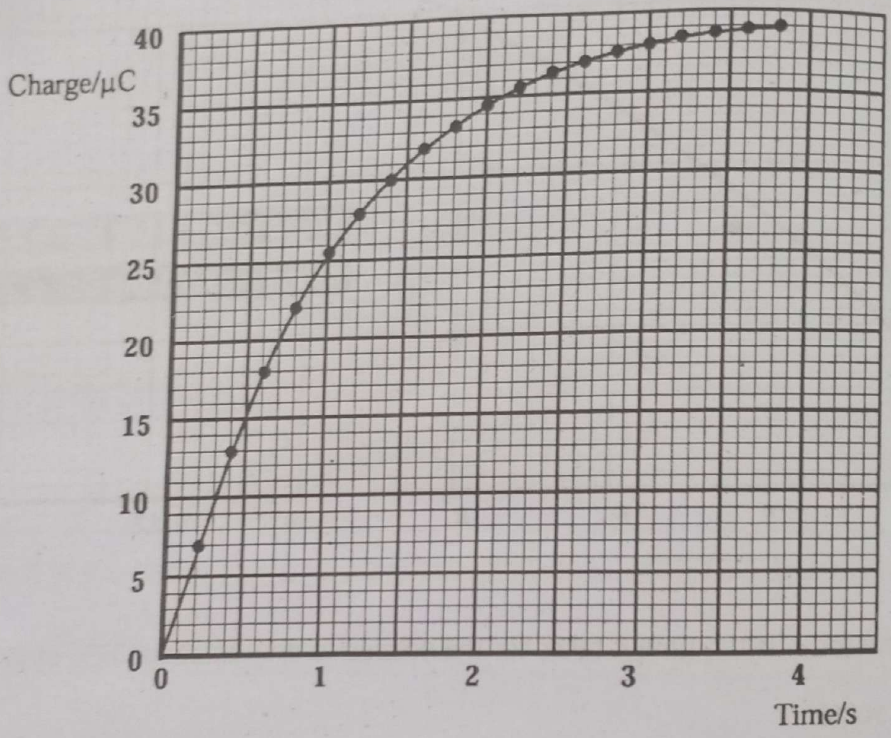
Current increases, and voltage lags current by a greater angle

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER-

Q.

(i) Draw the circuit shown is used to charge a capacitor, containing resistor, capacitor, key and batt

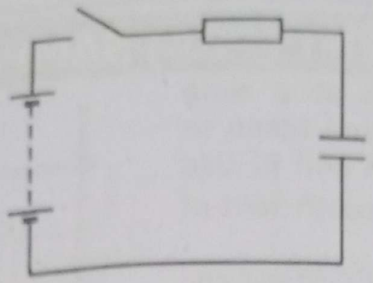
(ii) The graph shows the charge stored on the capacitor whilst it is being charged. On the same sketch as accurately as you can a graph of current against time. Label the current axis w appropriate scale. (2



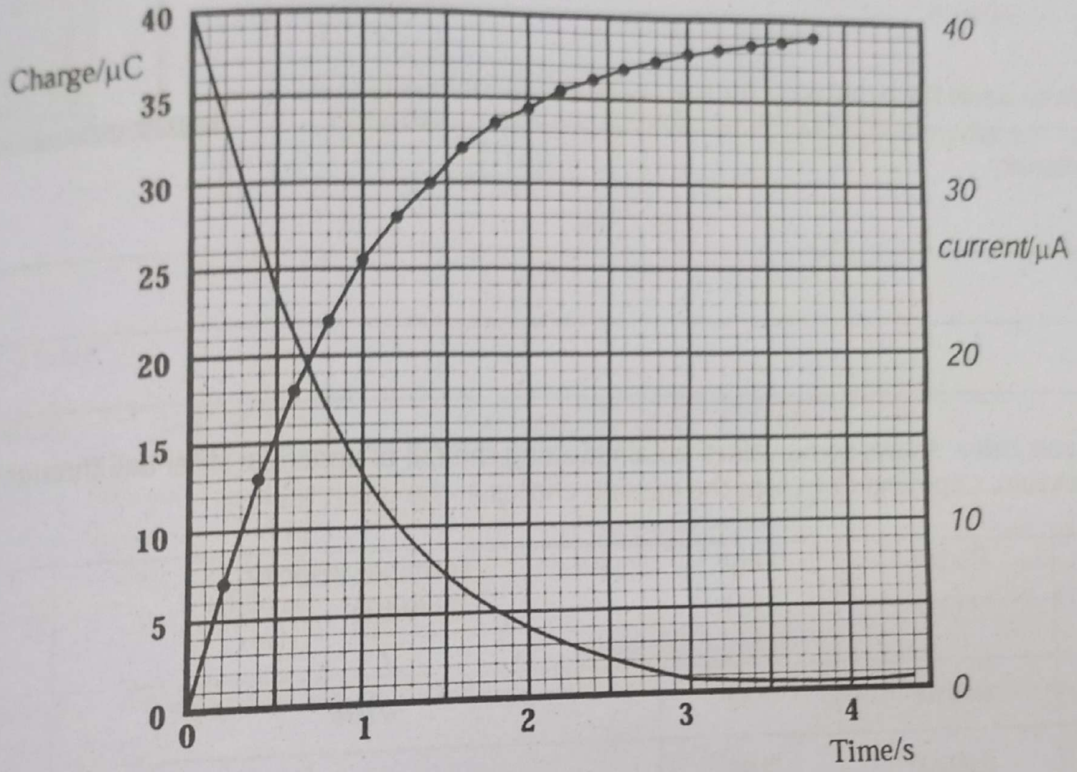
(iii) The power supply is 3 V. Calculate the resistance of the charging circuit? (

(iv) In order to maximize the usage time between charging the smart phone, the capacitor's manufa wishes to increase its time constant when discharging. State and explain how the manufacturer s adjust the resistance of the discharging circuit in order to increase the time constant. (

Solution: Practical Based Assessment (PBA) Sample Paper- 3



$I=\frac{\Delta Q}{\Delta t}$

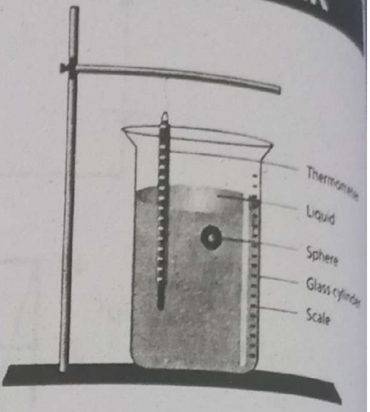


$$R=\frac{3.0V}{40\times10^{-6}A}=75\times10^{3}\,\Omega=75\,k\Omega$$

The time constant $t = RC$ determines how quickly the capacitor discharges
Manufacturers often prefer to increase the resistance R to increase the time constant rather than the capacitance C, because it is more practical for maintaining device size, cost, and charging performance.

SECTION A 60% : Marks 18

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER



Q.1. A student drops spherical steel balls one at a time through a column of glycerin and measures the time taken to travel a fixed distance $0.1\,m$ between two marks A and B. Use the data to calculate the terminal velocity and the coefficient of viscosity of glycerin.

Where Density of steel $= \rho_{steel} = 7850\,kg\,m^{-3}$ and Density of glycerin $= \rho_{glycerin} = 1260\,kg\,m^{-3}$

(i) Write down the expression for the viscous drag force acting on the sphere and explain how terminal velocity is related to viscosity. (1)

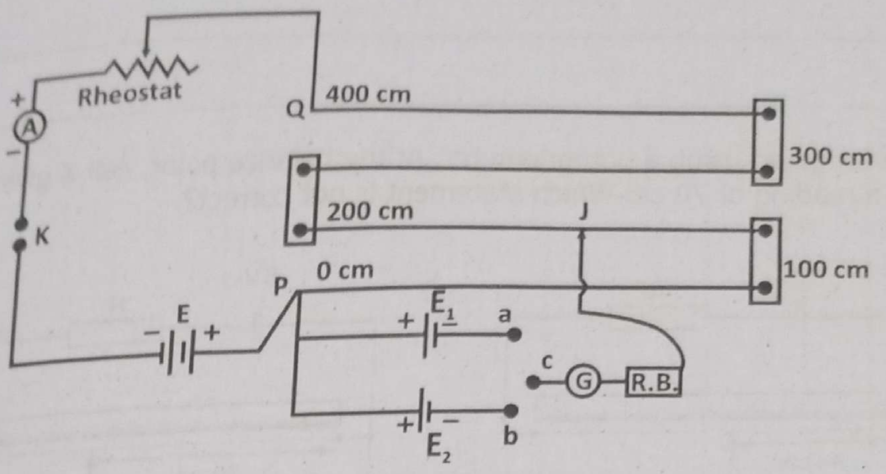
(ii) Table below shows some values obtained using the fall of spherical steel ball through a viscous medium. Copy and Complete the missing entries in the given table. (2)

Obs	Radius $r(m)$	Time $t(s)$	Terminal velocity $v_t = \frac{\ell}{t} = \frac{0.100}{t}$ $(m\,s^{-1})$	Viscosity
1	0.00200	2.80	0.036	
2	0.00200	2.90	0.035	
3	0.00200	2.70	0.037	

(iii) Explain why the ball reaches a terminal velocity, referring to the forces involved. (1)

(iv) The student repeats the experiment with a ball bearing of larger diameter. State and explain how the terminal velocity would differ. (2)

Q.2. In this experiment, you will compare the EMFs of two cells (Leclanché cell E_1 and Daniel cell E_2) using a potentiometer. A known length of wire is used, and balancing lengths are found by adjusting the position of a jockey until the galvanometer shows no deflection.



(02)

Complete the table

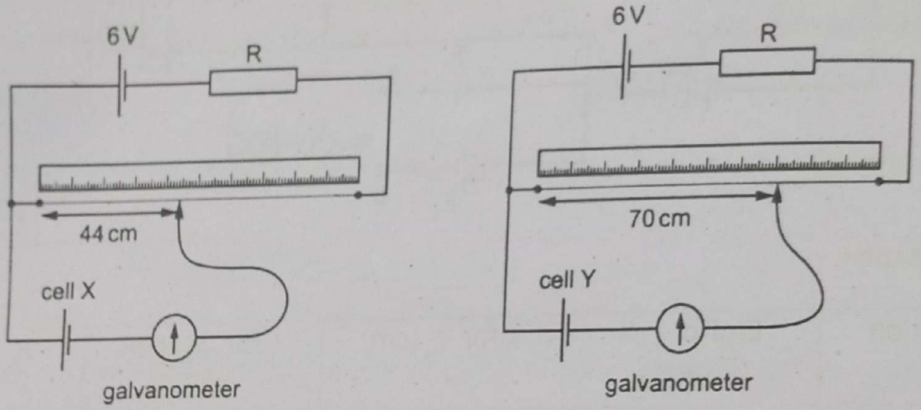
Observation	Emf of cell E (volt)	l_1 for E_1 (cm)	l_2 for E_2 (cm)	$\frac{E_1}{E_2}$ = ______
1	3	279	191	
2	3	350	265	
3	3	345	265	

Explain the purpose of finding the null point in this experiment and how it contributes to the accuracy of the EMF comparison. (01)

Explain the purpose of the jockey in the potentiometer experiment. Why is it important to use the jockey correctly? (01)

(iv) Describe how you would confirm that the potentiometer setup is ready for taking measurements

(v) Two cells are investigated using a potentiometer. At the balance point, cell X gives a reading of 44 c and cell Y gives a reading of 70 cm.Which statement is not correct? (01)


6 V
R
44 cm
cell X
galvanometer
6 V
R
70 cm
cell Y
galvanometer

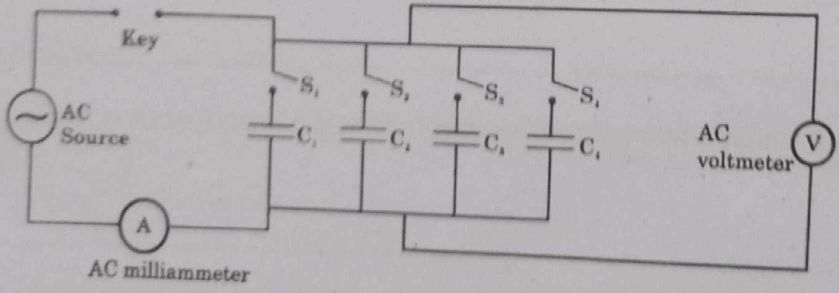
A A potentiometer balance point results in zero current through the galvanometer.

B At the balance point, the current through resistor R in both circuits is the same.

C The electromotive force (e.m.f.) of cell X is larger than that of cell Y.

D The value of the e.m.f. of each of the cells X and Y is less than 6V.

Q.3. A circuit consists of different capacitors connected in parallel to a 120 V, 60 Hz AC suppl The current- to-capacitance ratio remains constant for each capacitor.


Key
AC Source
S_1
S_2
S_3
S_4
C_1
C_2
C_3
C_4
AC voltmeter
V
A
AC milliammeter

Sr.No.	C (μF)	I (mA)
1	10	26
2	22	64
3	33	96
4	47	130
5	80	260
6	100	290

) Plot a graph of these results. (02)

) Determine the slope and interpret what it signifies about the nature of the circuit's response to changing capacitance (02)

i) Consider what would happen if you used different combinations of capacitors but kept the total capacitance constant. Would the measured current change? Why or why not? (01)

iv) Explain how the behavior of capacitors in an AC circuit differs from their behavior in a DC circuit, particularly with respect to current flow and energy storage. (01)

Solution: Practical Based Assessment (PBA) Sample Paper

Q.1

(i) Viscous drag force: F=6πηrv
Terminal velocity condition: at terminal velocity, viscous drag + upthrust = weight.

(ii)

Obs	radius $r(m)$	Time $t(s)$	Terminal velocity $v_t = \frac{\ell}{t} = \frac{0.100}{t}$ (ms^{-1})	Viscosity $\eta = \left(\frac{2}{9}\right) g(\rho_s - \rho_f)\left(\frac{r^2}{v}\right)$
1	0.00200	2.80	0.036	1.609
2	0.00200	2.90	0.035	1.666
3	0.00200	2.70	0.037	1.551

$$\eta_{mean} = \frac{1.609 + 1.666 + 1.551}{3} = 1.609\, kg\, m^{-1} s^{-1}.$$

$$\eta_{glycerin} = 1.61\, kg\, m^{-1} s^{-1} \ (to\ 3\ significant\ figures)$$

(iii) Initially, weight > drag + buoyancy, so accelerates
As speed increases, drag increases until forces balance (weight = drag + buoyancy), no net force, constant velocity.

(iv) The terminal velocity will be greater.
The viscous drag force is proportional to rv, but the weight (driving force) is proportional to r^3. Therefore, for a larger radius, a higher terminal velocity is required for the drag to balance the significantly larger weight.

Q.2

(i)

- Observation 1: $\frac{E_1}{E_2} = \frac{l_1}{l_2} = \frac{279}{191} \approx 1.46$
- Observation 2: $\frac{E_1}{E_2} = \frac{l_1}{l_2} = \frac{350}{265} \approx 1.32$
- Observation 3: $\frac{E_1}{E_2} = \frac{l_1}{l_2} = \frac{345}{265} \approx 1.30$

Mean $\frac{E_1}{E_2} = \frac{1.46 + 1.32 + 1.30}{5} \approx 1.36$

(ii) The null point is the position where the potential difference along the potentiometer wire balances exactly with the EMF of the test cell, resulting in zero current in the galvanometer. This allows measurement of EMF without drawing current from the cell, providing an accurate value unaffected internal resistance.

(iii) The jockey makes contact at different points along the potentiometer wire. It helps in precisely loca the null point, where the potential difference across the wire matches the EMF of the cell. Proper us prevents damage to the wire or uneven resistance.

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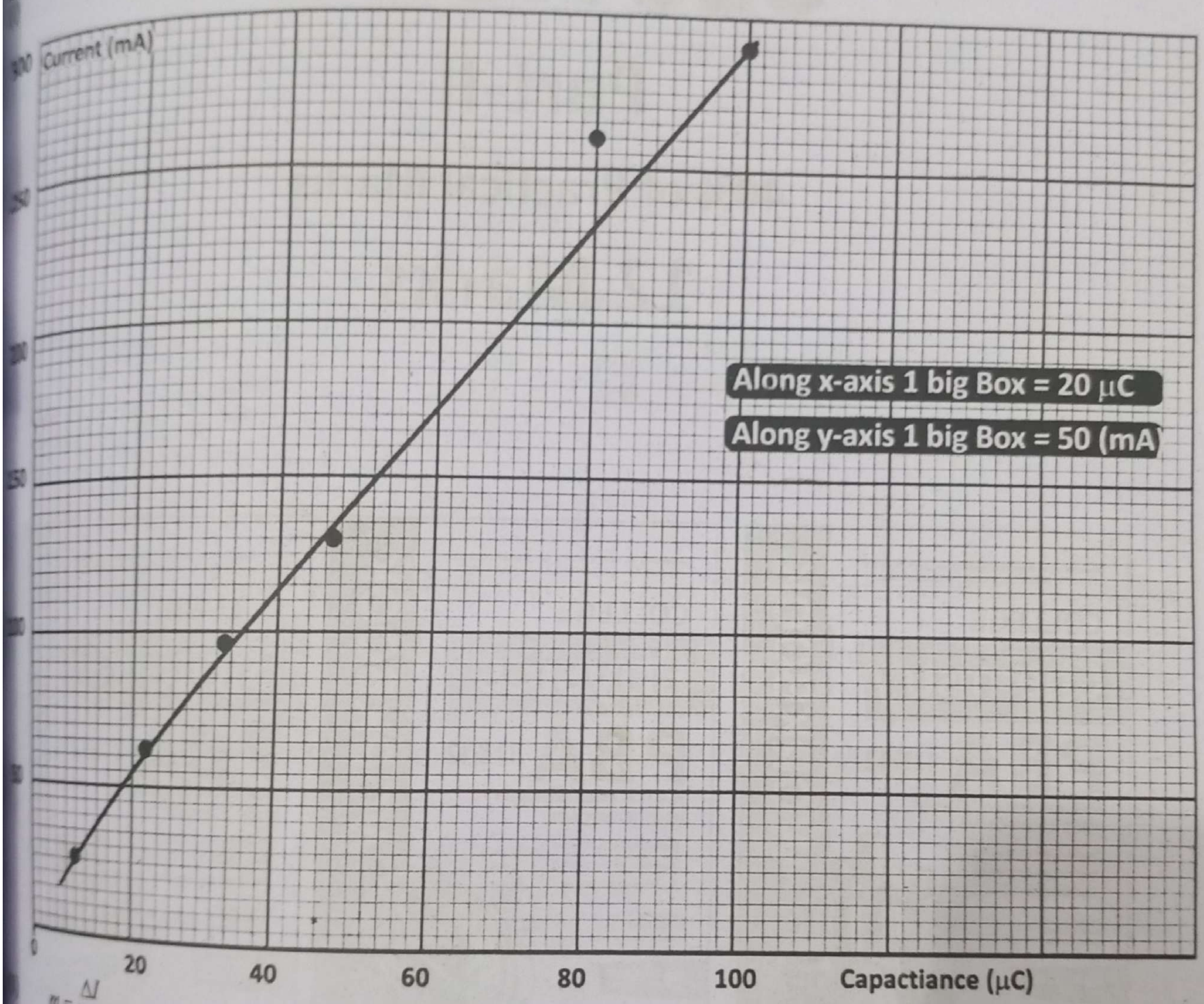
- By adjusting the rheostat to set an appropriate current in the primary circuit, ensuring the wire doesn't heat up.
- By ensuring the galvanometer shows opposite deflection when touched with two ends of potentiometer.

This preparation ensures accurate null-point readings during the experiment.

C

03.



$m = \frac{\Delta I}{\Delta C}$

The plot of I versus C gives a linear slope, indicating that the current increases linearly with capacitance due to the inverse relationship between reactance and capacitance.

Using different combinations with the same total capacitance results in the same overall reactance, and thus, the current remains unchanged.

In DC circuits, capacitors block steady current once charged. In AC circuits, capacitors continuously charge and discharge, allowing alternating current to flow with a phase shift.

SECTION B

40% of practical marks

12 Marks

Part-2 (SLO)

[SLO: P-11-B-28]
[SLO: P-12-E-20]
[SLO: P-12-F-10]

[SLO: P-11-B-30]
[SLO: P-12-F-06]

[SLO: P-09-E-35]
[SLO: P-12-F-07]

[SLO: P-12-B-07]
[SLO: P-12-F-08]

[SLO: P-12-E-1
[SLO: P-12-F-0

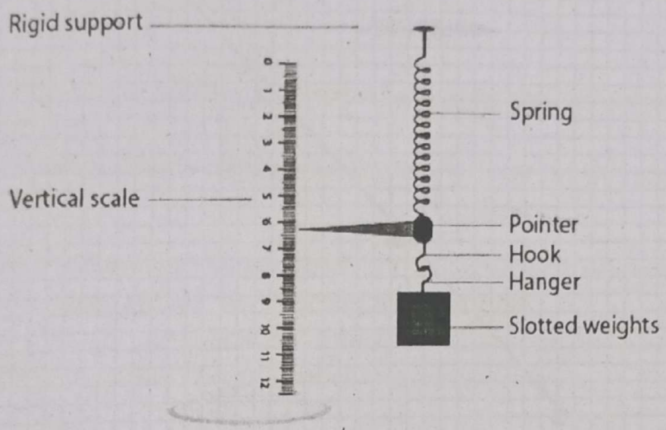
Sr.#	PRACTICALS	PA
1.	**Calculate elastic potential energy from the load-extension graph for vertical mass spring system.**	7
	PBA Sample paper – 1, 2 & 3 with solutions (Each Test : 04 Marks)	8
2.	**Sketch magnetic field pattern due to the currents in a long straight wire/ a flat circular coil/ a long solenoid.**	8
	PBA Sample paper – 1, 2 with solutions (Each Test : 04 Marks)	9
3.	**Investigate the value of 'g' by free fall method using electronic timer.**	9
	PBA Sample paper – 1, 2 with solutions (Each Test : 04 Marks)	9
4.	**Study the input and output waveforms for half wave rectification using CRO. (Questions will not be asked from CRO)**	10
	PBA Sample paper – 1, 2 with solutions (Each Test : 04 Marks)	10
5.	**Study the input and output waveforms for full wave rectification using CRO. (Questions will not be asked from CRO)**	10
	PBA Sample paper – 1, 2 & 3 with solutions (Each Test : 04 Marks)	10
6.	**To study variation of electric current with intensity of light using photoelectric apparatus.**	11
	PBA Sample paper – 1, 2 & 3 with solutions (Each Test : 04 Marks)	11
	MODEL PAPERS SECTION-B MARKS 12	
	PBA TEST with Solution **(Each Test: 12 Marks)**	12
	MODEL PAPERS MARKS 30	
	FBISE PBA MODEL PAPER FOR EXAMS 2026 with solution (30 Marks) PRACTICE MODEL PAPER – 1 with solution (30 Marks) PRACTICE MODEL PAPER – 2 with solution (30 Marks)	12 13 14

1

CALCULATE ELASTIC POTENTIAL ENERGY FROM THE LOAD-EXTENSION GRAPH FOR VERTICAL MASS SPRING SYSTEM.

aratus

Spring, Mass Hanger, Slotted Masses, Clamp Stand with Boss and Clamp, Meter Ruler



Extension of spring

edures

pend the spring from the clamp so it hangs vertically. Place the meter rule immediately behind the nter; zero the rule at the unloaded position

d the empty mass hanger; record the new pointer reading – this is "zero-load" datum if the hanger itself ses any extension.

rease the load in even steps by adding slotted masses.

er each addition, allow the system to settle, and then record the total suspended force, F (N), and the pointer position, x (mm).

culate extension x = L – L₀.

a graph of load (F) on the y-axis versus extension (x) on the x-axis.

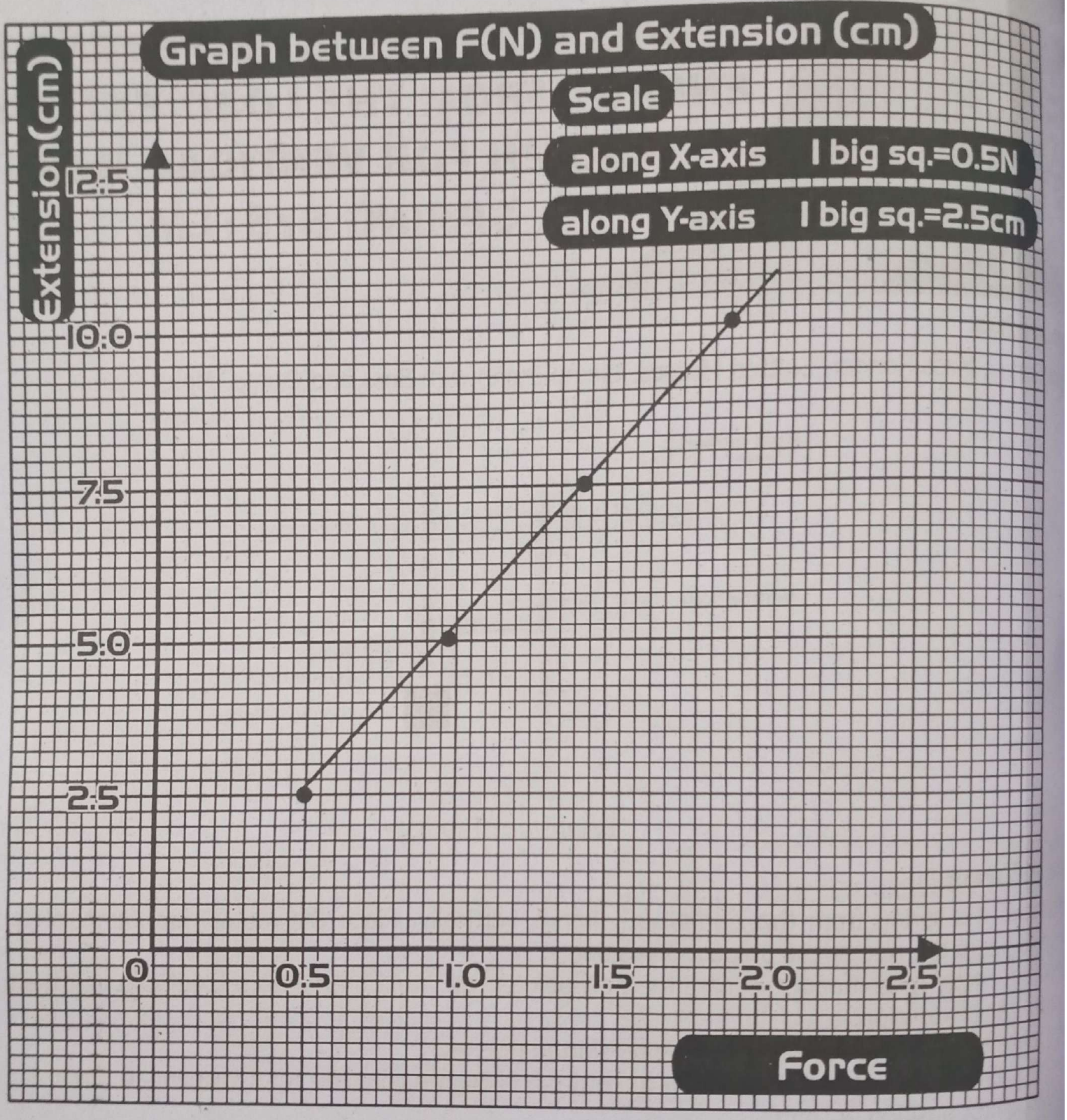
graph should be a straight line passing through the origin (or near it) if Hooke's law holds.

find the elastic potential energy for a specific extension, calculate the area under the graph up to that ension.

ervations

o.	Total Mass (m) g	Load (F = mg) N	Initial Length ℓ_o cm	Final Length ℓ cm	Extension $x = \ell_o - \ell$ cm
1	50	0.49	10.0	12.5	2.5
2	100	0.98	10.0	15.0	5.0
3	150	1.47	10.0	17.5	7.5
4	200	1.96	10.0	20.0	10.0
5	250	2.45	10.0	22.5	12.5

Graph and Calculations



The slope of the line gives the spring constant

$$k=\frac{\Delta F}{\Delta x}=\frac{2.45N-1.47N}{(12.5-7.5)\times10^{-2}m}=19.6\,Nm^{-1}$$

For an extension x, elastic potential energy = area under the curve

$$E=\frac{1}{2}F\Delta x=\frac{1}{2}(1.96N)(10\times10^{-2}m)=0.098J$$

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

Does the spring obey Hooke's law over the range used? Give a brief reason referring to the graph.

Yes, the graph is linear through the origin, so $F \propto x$ and Hooke's law holds

The spring obeys Hooke's law over the range if the plotted load vs extension graph is a straight line through the origin (i.e., gradient constant).

If the graph shows that the last point lies slightly above the straight-line trend. State briefly what this indicates about the spring behaviour and give one short physical reason.

The last point lying above the linear trend indicates the spring no longer obeys Hooke's law fully at the highest load.

Reason:

The spring may be approaching its elastic limit so the extension increases more than predicted by the straight-line trend.

State and explain how the total elastic potential energy stored when the extension can be determined from this graph.

The area under a force-extension graph represents the work done on the spring, which is equal to the energy stored.

If a graph of load against extension is plotted, explain why it should pass through the origin and what this indicates about the spring's behavior.

The graph passes through the origin because there is no extension when no load is applied; this indicates the spring obeys Hooke's law (proportional relationship) with no permanent deformation.

The student suggests that a spring with a larger spring constant will always store more energy for the same applied load. Is this correct? Explain your answer.

The statement is not correct.

Justification:

For the same load F, $\downarrow E = \frac{1}{2} F (x \downarrow)$

- A stiffer spring (larger k) will have a smaller extension $\left(\downarrow x = \frac{F}{k \uparrow} \right)$ for the same load.
- Therefore, the energy stored will actually be less for a spring with a larger spring constant.

Explain why the elastic potential energy stored in the spring for a given extension is equal to the area under the load-extension graph up to that extension.

The area under the graph represents the work done in stretching the spring, which is transferred to elastic potential energy

Consider plot a graph of F (y-axis) against e (x-axis). State what feature of the graph shows that the spring obeys Hooke's law.

For an ideal spring, the load is directly proportional to the extension. $F \propto x$

This means a graph of load against extension should be a straight line passing through the origin.

Sketch on your graph the line you would expect, if a softer spring of half the original k were used. Explain the difference in gradient.

New line shallower (half gradient) because for same F, extension doubles

$$\Delta x = \frac{\Delta F}{k} \qquad \Delta x' = \frac{\Delta F}{k'} = \frac{\Delta F}{\frac{k}{2}} = 2\left(\frac{\Delta F}{k}\right) = 2\Delta x$$

9. **Suggest a reason why the actual values of extension for very large loads might be sm than the values predicted by the graph.**

Ans: For very large loads, the spring may have been stretched beyond its elastic limit. When this happens, it no longer obeys Hooke's Law, and the extension becomes smaller than w linear relationship would predict.

10. **Explain what is meant by elastic potential energy.**

Ans:

- ability to do work
- as a result of a change of shape of an object/stretched etc

11. **A spring that obeys Hooke's law has a spring constant k.**
Show that the energy E stored in the spring when it has been extended elastically b amount x is given by

Ans: $E = \frac{1}{2}kx^2$

Work = average force. Distance moved (in direction of the force) = $= \frac{1}{2}Fx$

Work is area under F-x graph $= \frac{1}{2}Fx$ $\therefore F = kx$

so work / energy = $E = \frac{1}{2}kx^2$

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

Q. A student sets up a vertical spring system and adds masses to stretch the spring, easuring the extension each time to investigate elastic potential energy. The spring obeys ooke's law.

Mass added m g	Extension cm	Load F N	Extension x m
50	5.0		
100	10.0		
150	15.0		
200	20.0		

Copy and complete the last two columns (1)

Plot a graph of Load, F, on the y-axis against Extension, x, on the x-axis. Use the graph to determine the spring constant, k. (2)

Calculate the elastic potential energy stored when the mass is 200 g. Show working. (1)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

Q. A 10 g hanger plus a 0 – 250 g slotted-mass set is suspended from a steel spring. The top of the spring is clamped to a retort stand and a ruler is fixed vertically alongside.

Mass added *g*	Total mass *g*	Extension *cm*	Load *N*	Extension *m*
		6.0		
50		12.0		
100		18.1		
150		24.0		
200		30.2		
250				

(i) Copy and complete the columns. (1)

(ii) Sketch on your graph and what is the spring constant k (state how obtained briefly)? (2)

(iii) State and explain how the total elastic potential energy stored when the extension is 0.181 m can determined from this graph. (1)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER-3

A vertical spring system is used to study elastic potential energy. A student observes that ring is stretched by applying forces. The data collected is shown below.

ht spring of unextended length 14.2cm is suspended vertically from a fixed as illustrated in Fig. 1.

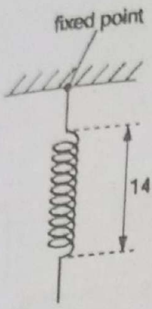


Fig. 1

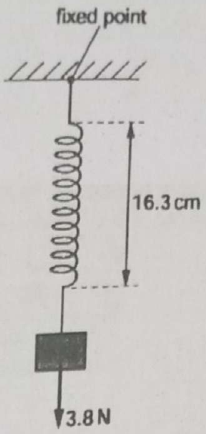


Fig. 2

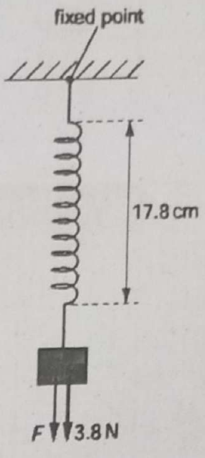


Fig. 3

of weight 3.8N is hung from the end of the spring, as shown in Fig. 2. The length of the spring is now cm.

tional force F then extends the spring so that its length becomes 17.8cm, as shown in Fig. 3.

spring obeys Hooke's law and the elastic limit of the spring is not exceeded.

Show that the spring constant of the spring is $1.8\,Ncm^{-1}$. (1)

Show that the change in elastic potential energy of the spring is 0.077J. (2)

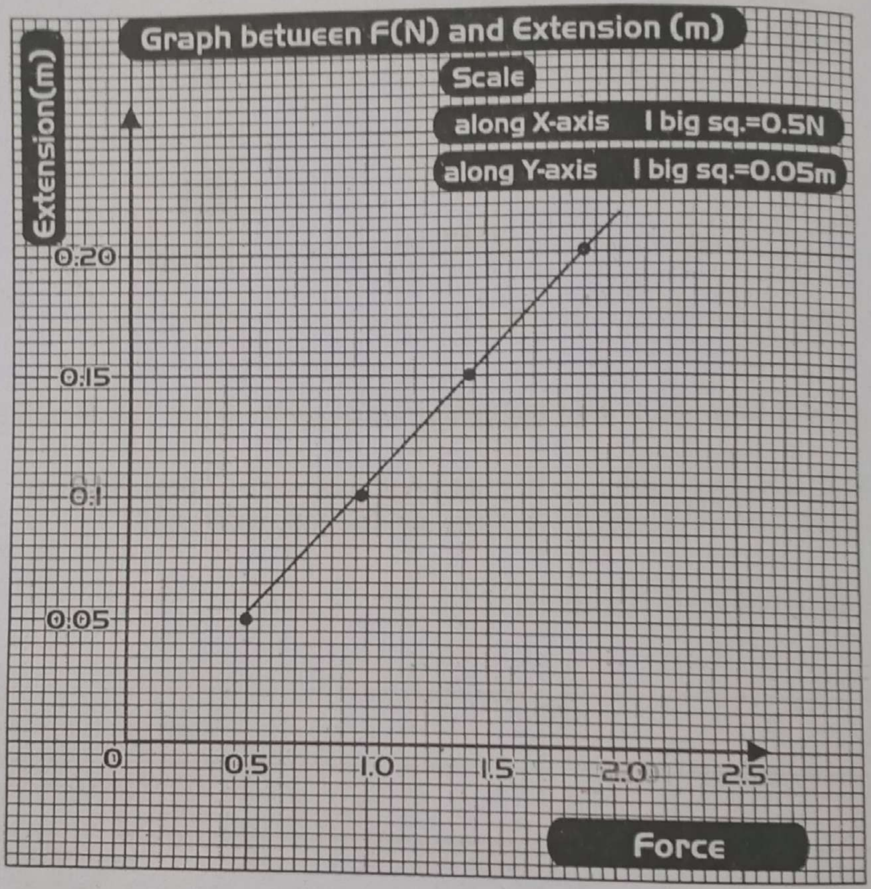
If a graph of load against extension is plotted, explain why it should pass through the origin and what this indicates about the spring's behavior. (1)

Solution: Practical Based Assessment (PBA) Sample Paper-1

(i)

Mass added g	Extension cm	Load $F = mg$ N	Extension m
50	5.0	0.491	0.050
100	10.0	0.981	0.100
150	15.0	1.47	0.150
200	20.0	1.96	0.200

(ii)



The spring constant k is the gradient of the graph $\frac{\Delta F}{\Delta x}$.

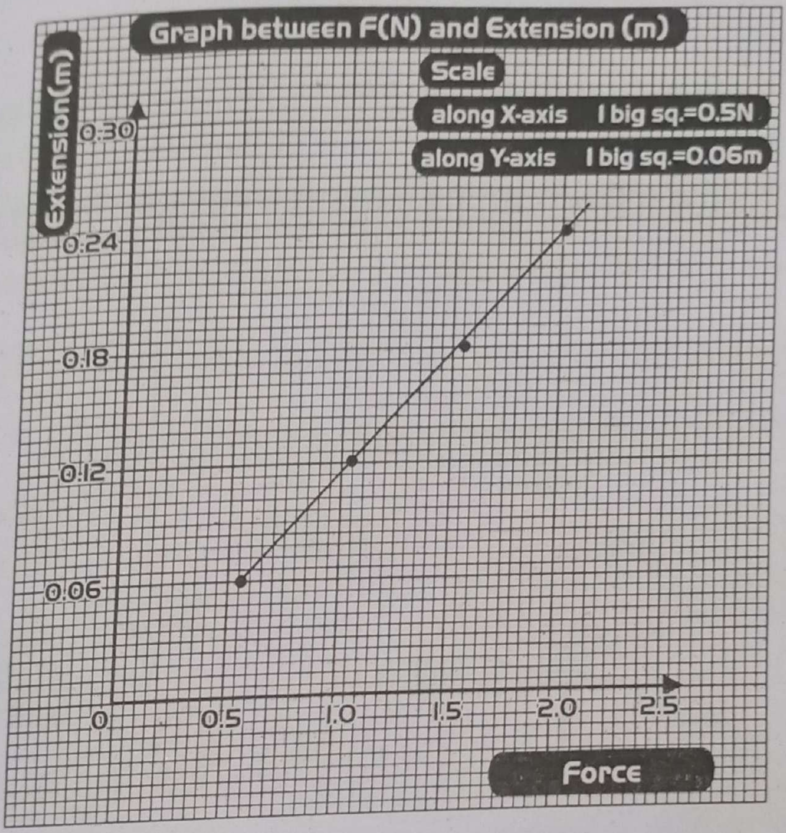
$$k = \frac{\Delta F}{\Delta x} = \frac{1.47 - 0.981}{0.15 - 0.1} = \frac{0.489}{0.05} = 9.78\ Nm^{-1}$$

The graph should be a straight line through the origin, as load $F = kx$ according to Hooke's law the elastic limit.

(iii) $$E = \frac{1}{2} F \Delta x = \frac{1}{2}(2)(0.2) = 0.2J$$

Solution: Practical Based Assessment (PBA) Sample Paper- 2

Mass added g	Total mass g	Extension cm	Load N	Extension m
50	60	6.0	0.588	0.060
100	110	12.0	1.078	0.120
150	160	18.1	1.568	0.181
200	210	24.0	2.058	0.240
250	260	30.2	2.548	0.302



The spring constant k is the gradient of the graph $\frac{\Delta F}{\Delta x}$.

$$k=\frac{\Delta F}{\Delta x}=\frac{2.058-1.568}{0.240-0.181}=8.03\,Nm^{-1}$$

$$E=\frac{1}{2}Fx=\frac{1}{2}\left(8.03Nm^{-1}\right)\left(0.181m\right)^2=0.1315J$$

Solution: Practical Based Assessment (PBA) Sample Paper- 3

$$k=\frac{F}{\Delta x}=\frac{3.8\,N}{16.3cm-14.2\,cm}=\frac{3.8\,N}{2.1\,cm}=1.8\,Ncm^{-1}$$

$$E=\frac{1}{2}F\Delta x=\frac{1}{2}\left(1.8\times10^2\,Nm^{-1}\right)\left[\left(0.036m\right)^2-\left(0.021m\right)^2\right]=0.077J$$

The graph passes through the origin because there is no extension when no load is applied, this indicates the spring obeys Hooke's law (proportional relationship) with no permanent deformation.

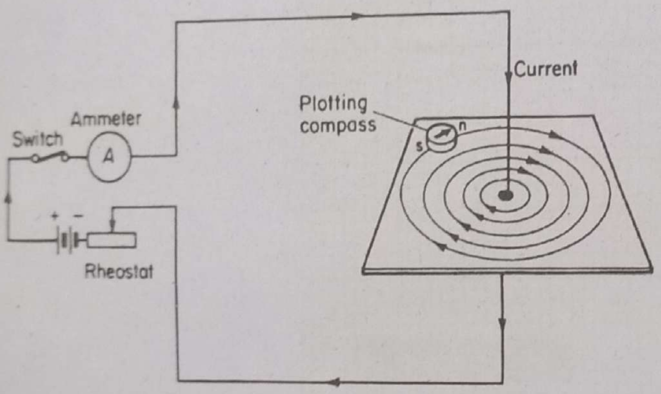
PRACTICAL 2

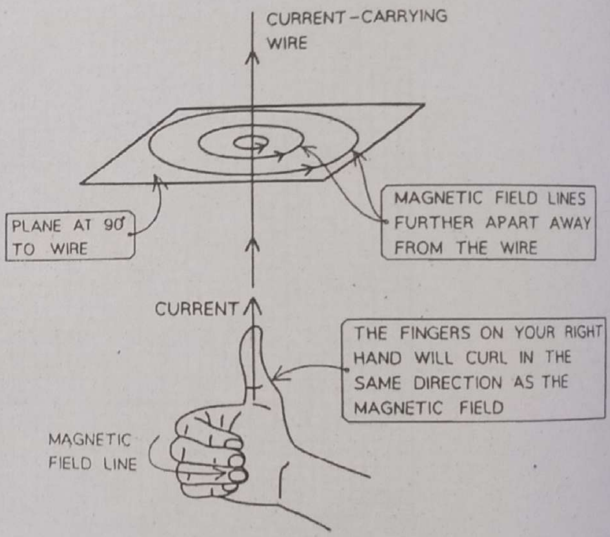
SKETCH MAGNETIC FIELD PATTERN DUE TO THE CURRENTS IN A LONG STRAIGHT WIRE/ A FLAT CIRCULAR COIL/ A LONG SOLENOID.

Apparatus

Power supply (DC), straight copper wire, circular coil, long solenoid, Stand and clamps, Cardboard sheet, magnetic compass, Switch, Connecting wires

(I) MAGNETIC FIELD AROUND A CURRENT-CARRYING WIRE


Current
Plotting compass
n
s
Ammeter
A
Switch
+ -
Rheostat


CURRENT-CARRYING WIRE
PLANE AT 90° TO WIRE
MAGNETIC FIELD LINES FURTHER APART AWAY FROM THE WIRE
CURRENT
THE FINGERS ON YOUR RIGHT HAND WILL CURL IN THE SAME DIRECTION AS THE MAGNETIC FIELD
MAGNETIC FIELD LINE

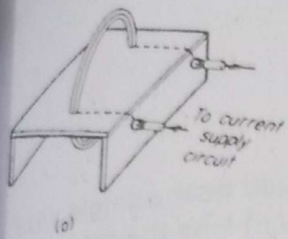
Procedures

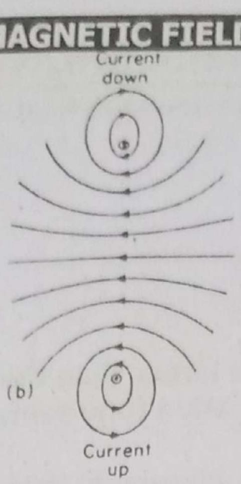
21. Fix the copper wire vertically through the center of a cardboard sheet using a clamp.
22. Connect the ends of the wire to the DC power supply using connecting wires and a switch.
23. Close the switch to allow current to pass through the vertical wire.
24. Use a small magnetic compass and move it at different points around the wire to trace the field direction.

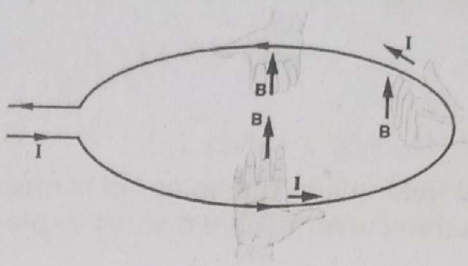
Observations

1. Magnetic field lines in a current-carrying wire are circular rings, centred on the wire
2. The field lines are closer together near the wire, where the field is strongest
3. The field lines become further apart with distance from the wire as the field becomes weaker
4. Reversing the current reverses the direction of the field

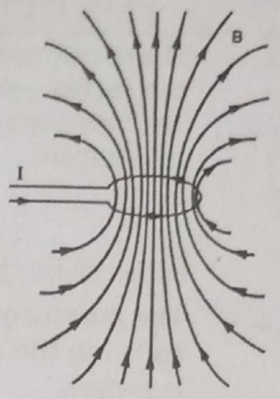
(II) MAGNETIC FIELD AROUND A FLAT CIRCULAR COIL


To current supply circuit
(a)


Current down
(b)
Current up



(a)



(b)

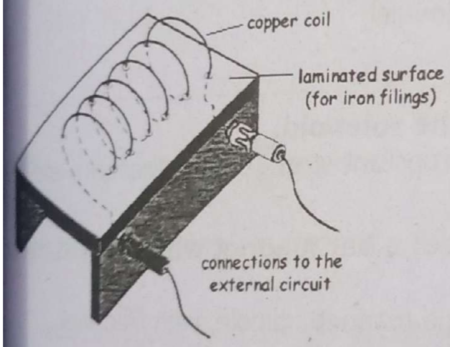
Procedures

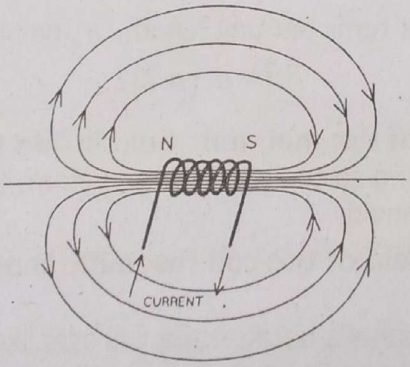
1. Fix the circular coil horizontally on a stand so that it's flat.
2. Place a cardboard sheet or paper over it, or mark its outline.
3. Connect the coil to a DC power supply with a switch.
4. Place magnetic compass on board, Pass current through the coil.
5. Observe the magnetic field pattern. Sketch the pattern. Use Right-Hand Rule to indicate direction.

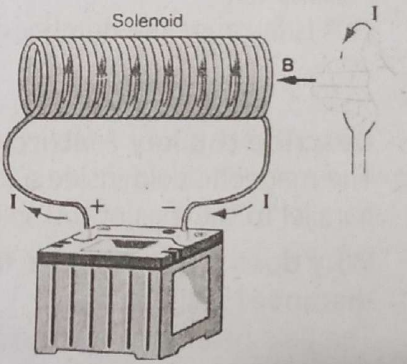
Observations

The field lines emerge through one side of the circle (north pole) and enter through the other (south pole)

(III) MAGNETIC FIELD AROUND A SOLENOID


copper coil
laminated surface (for iron filings)
connections to the external circuit




Solenoid
I
B
I
+
–
I

Procedures

1. Place the solenoid horizontally and fix it in position.
2. Lay a sheet of paper or cardboard over it.
3. Connect the solenoid to a DC power supply through a switch.
4. Place the magnetic compass along the solenoid and around its ends.
5. Switch on the current and Sketch the field pattern. Mark N and S poles.

Observations

1. One end of the solenoid becomes a north pole and the other becomes the south pole
2. As a result, the field lines around a solenoid are similar to a bar magnet
3. The field lines emerge from the north pole and The field lines return to the south pole.
4. The poles of the solenoid can be determined using the right-hand grip rule
    - The curled fingers represent the direction of the current flow around the coil
    - The thumb points in the direction of the field inside the coil, towards the north pole

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

1. **If the coil radius is doubled (all else same), how does the field at the centre change? Sta the factor and give one sentence justification**

Ans: The field becomes half

Justification:

$$B \propto \frac{1}{R}$$

For a coil centre, doubling R halves B

2. **The measured field inside the solenoid is much larger than the field near a single wire carrying the same current. Give a short explanation (one sentence) why the solenoid fie is larger.**

Ans: Magnetic fields from many closely-spaced turns add (superpose) inside the solenoid, giving a larger field proportional to turn density n

3. **State how the spacing of the field lines indicates the strength of the magnetic field.**

Ans: The magnetic field is stronger where the field lines are closer together. The spacing increases with distance from the wire, showing the field weakens.

4. **State one way to increase the strength of the magnetic field at the centre of the coil.**

Ans: Increase the current in the coil.

Increase the number of turns on the coil (making it part of a solenoid).

5. **The solenoid is compressed so that its length is halved but the number of turns remains the same. State and explain the effect on the strength of the magnetic field inside the solenoid.**

Ans: The magnetic field strength inside the solenoid will increase.

Explanation:

This is because the number of turns per unit length, n, has doubled.

$$B\uparrow = \mu_o (n\uparrow) I$$

6. **Describe the key feature of the magnetic field inside the solenoid.**

Ans: The magnetic field inside a long solenoid is strong, uniform (constant strength and direction), and parallel to the axis of the solenoid.

7. **Why does the magnetic field of the coil resemble that of a bar magnet when viewed from distance?**

Ans: The field resembles a bar magnet's because the coil acts like a magnetic dipole, with field lines emerging from one side (like a north pole) and returning to the other (like a south pole).

8. **How can the strength of the magnetic field inside the solenoid be increased without changing the current?**

Ans: By increasing the number of turns per unit length (n) or by inserting a soft-iron core.

9. **State right hand rule.**

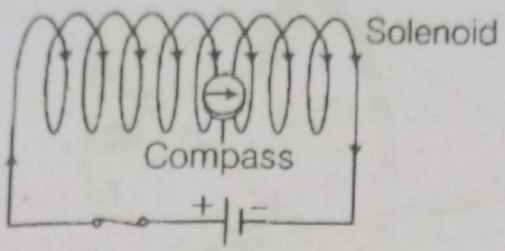
Ans: According to right hand rule if we hold a conductor in our right hand with thumb indicating the direction of current, then direction of magnetic filed with be shown by the curled fingers around the conductor.

10. **Define magnetic lines of force?**

Ans: Magnetic lines of force is a vector quantity. It starts from north pole and ends at the south pole. It is line straight or curved w.r.t which an isolated north pole tends to move in a magnetic field if free to so.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

A student investigates the magnetic field inside and outside a long solenoid (many turns) ing a small compass to map field direction and approximate uniformity inside.



Sketch the magnetic field of the solenoid in a plane containing its axis (show inside and outside). (1)

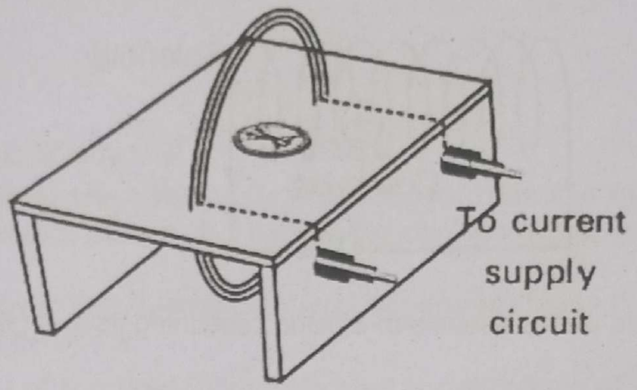
State and explain the uniformity of the field inside a long solenoid. (1)

What happens to the field if the solenoid is made longer (more turns per unit length kept same)? Explain. (1)

Explain why the field outside is much weaker than inside. (1)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER-2

Q A student studies the magnetic field produced by a flat circular coil passing vertically on board. A compass is used to map the field on the axis of the coil and in the plane of the coil.



i. Sketch the magnetic field pattern for the coil in a plane containing the coil axis (show inside and outside) (1)

ii. State the direction of the field on the coil axis when current flows clockwise as viewed from front. (1)

iii. Explain how field strength on axis changes with distance from the coil centre. (1)

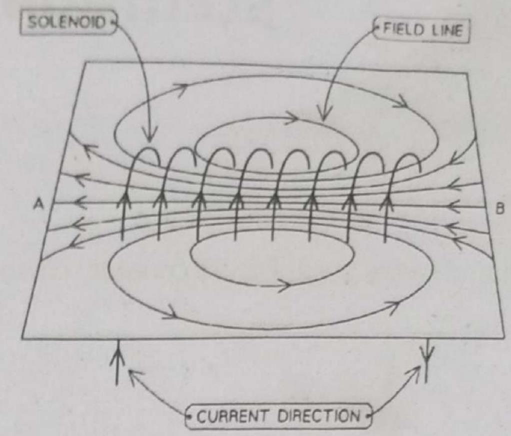
iv. If the student uses 5 concentric turns instead of a single turn, how does the axial field at the centre change? Explain. (1)

CS CamScanner

Solution: Practical Based Assessment (PBA) Sample Paper-

Inside: nearly parallel straight field lines along the axis, uniform in direction and roughly evenly s

Outside: field lines loop from one end to the other, spread out and much weaker.



By superposition of fields from many turns, contributions inside add constructively produc almost uniform field; end effects localized near ends.

For same turns per unit length and same current, making the solenoid longer (increasing lengtl keeping n constant) reduces end effects fraction → interior becomes more uniform and the field approaches μ0nI.

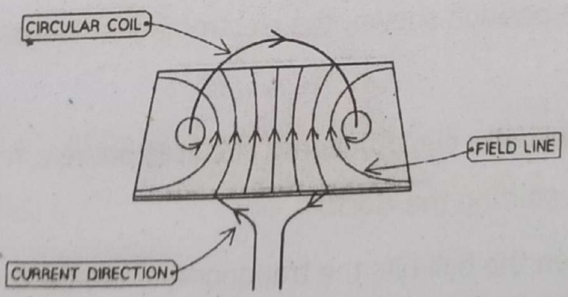
Outside contributions from closely spaced turns largely cancel, and the field lines spread over a area; hence lower magnitude.

Solution: Practical Based Assessment (PBA) Sample Paper-

Inside (through centre) field lines are approximately straight and perpendicular to the plane of the cc pointing along the axis

Outside lines curve away and close back around the coil, forming loops.

Indication that field is strongest near centre and weakens away



Use right-hand rule for a loop: if current is clockwise when viewed from front, the field points downw along the axis (i.e., into the page beneath the coil).

Field is maximum at centre and decreases with distance along axis.

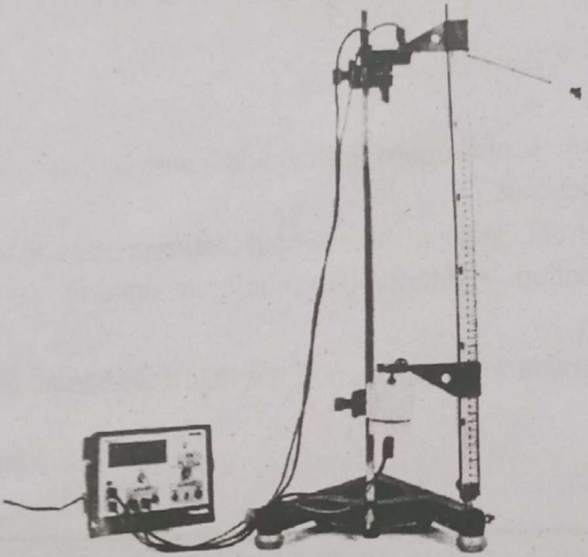
Field at centre approximately multiplies by number of turns N (i.e., 5 turns → field ≈5× single-turn because each turn adds its contribution linearly.

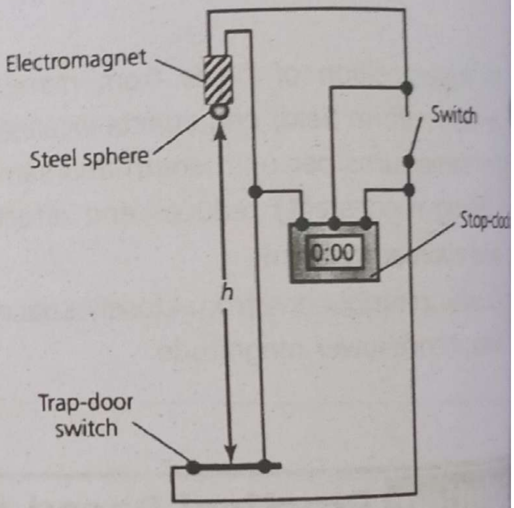
3

INVESTIGATE THE VALUE OF 'g' BY FREE FALL METHOD USING ELECTRONIC TIMER.

aratus

rode electromagnet, Ball and metal base, Digital counter, Power supply: 100-240V AC 50-60 Hz





cedures

he time is measured using an electronic stop clock that reads to 1/100th of a second.

hen the switch is in the position shown, the electromagnet is activated and holds the steel ball

lace.

hen the switch is thrown, the electromagnet circuit is broken, releasing the ball, and simultane

lock circuit is activated, starting the clock.

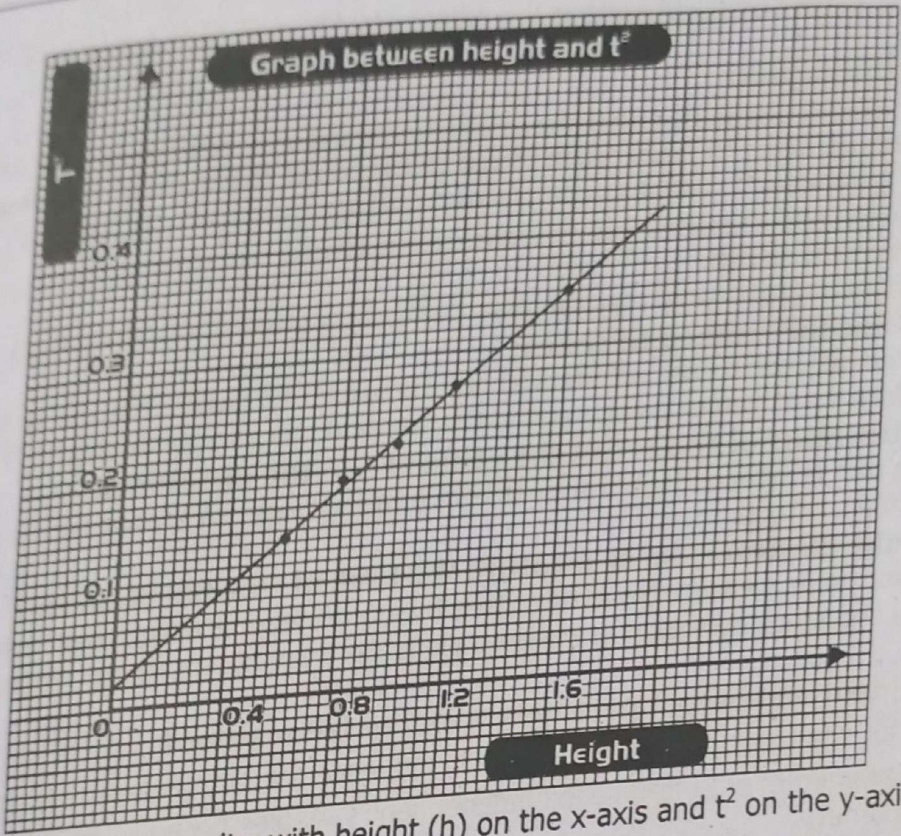
The clock is stopped when the ball hits the trapdoor and breaks the circuit.

The time should be determined at least three times and averaged for each height, over as wide a

heights as possible

bservations

No. of Obs.	Height of free fall h (cm)	Time of free fall t_1 (sec)	Time of free fall t_2 (sec)	Mean time $t=\frac{t_1+t_2}{2}$ (sec)	Value of g $g=\frac{2h}{t^2}$ (cm / sec^2
1	70	0.38	0.38	0.38	969.52
2	75	0.39	0.39	0.39	986.19
3	80	0.40	0.40	0.40	970.66



results to Plot a graph of our results, with height (h) on the x-axis and t^2 on the y-axis.

h (m)	0.600	0.800	1.000	1.200	1.400	1.600
t (s)	0.38	0.44	0.47	0.52	0.56	0.59
t^2 (s^2)	0.14	0.19	0.22	0.27	0.31	0.35

The graph should be a straight line through the origin and the gradient should be equal to ½g.

$$\text{gradient}=\frac{(0.35-0.02)s^2}{(1.60-0.00)m}=0.20(6)s^2m^{-1}=\frac{2}{g}$$

What is the value of "g" from your graph?

$$g=\frac{2}{0.20(6)s^2m^{-1}}=9.7ms^{-2}$$

$$\%\text{difference}=\left(\frac{9.7ms^2-9.8ms^2}{9.8ms^2}\right)100\%=-1.02\%$$

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

What is the use of electronic timer?

Electronic timer can measure the time unto Millisecond. It is used to measure the time for the during its fall from electromagnet to when it just hit the plate.

How much distance covered by a freely object in two second?

The distance covered by the object in one second will be 4.9m.

$h=?$ $t=1$ sec

$h=vt + \frac{1}{2} gt^2 = 0 + \frac{1}{2}(9.8)(2)^2 = 19.6$ m

What is the value of 'g' and 'G'?

The value of 'g' at the surface of earth is 9.8m/sec^2 and value of 'G' is 6.673×10^{-11} Nm^2/kg^2 at place.

What is electromagnet?

The magnetic field is produce around the conductor by passing electric current is called electro

How does the value of 'g' vary from place to place on the surface of the earth?

The value of 'g' remains constant at one place, but varies from place to place. It decreases with increase of height and increases from equator to the poles.

Define the term free fall.

It is the fall of body from certain height toward the earth under the action of gravity.

Why is the free fall method so called?

It is called free fall method because to find out the value of g ,which holds only for a body fallin from rest under the action of gravity and in this method metallic bob fulfills this requirement.

How does the mass of bob affect the value of g in the experiment?

As the value of g is independent of the mass of a falling body, so the value of g will not change change the mass of bob.

How does the electronic timer measure the time of free fall accuracy?

The electronic timer measure the time of free fall accurately because it start automatically when begin to fall and stops by touching the drop plate. So there is no chance of personal error to me the time.

What are input and output parameters in free fall method?

For a free fall, the input parameters (h and t) influence the output parameter (g).

- Input parameters are often called independent variables because they can be varied indepe of each other.
- The output parameters, on the other hand, may be called dependent variables because their depend on the inputs.

What are the Uncertainties in free fall experiment?

Uncertainties arise in four ways:

- Starting the timer.
- During the ball's descent, due to air resistance or other factors.
- Stopping the timer.
- Determining the height of the fall.

How Percentage error in the experiment can be determined?

%difference = [(your result – accepted value) / accepted value] x 100%

Suppose that the initial height of the object were measured from the top of the obje the release point to the floor. How would this affect your experimental result for g, th would it be too high or too low? Is this a random or a systematic error?

Measuring object's height overestimates g (gravity). You're including the object's own size, not j fall distance. This is a systematic error: always overestimates, needs correction.

How to Fix: Measure from bottom of objects or release point, not top. This gives the actual fall dis and a more accurate g.

Suggest how the students could modify the setup to investigate the effect of air resista on the calculated value of g

Use balls of different masses or sizes (densities) and compare calculated g values to investigate th effect of air resistance.

Lighter or larger balls yield lower g due to greater air resistance increasing t.

Describe a potential source of systematic error in the height measurement and how to minimize it.

Source: Parallax error when reading ruler.

Minimize: Use a digital height sensor or view perpendicular to scale.

Suggest one source of systematic error in measuring time, and describe how to minimi it.

Source: magnetic gates misaligned, causing early or late triggering

Minimize: Use a laser level or plumb line to ensure gates are vertically aligned

Does a heavier object fall faster than a lighter object?

No! All objects fall at the same rate regardless of their mass due to a principle called univ gravitation. However, in the real world with air resistance, heavier objects fall slightly faster bec the force of gravity pulling them down is larger compared to the air resistance acting on them.

Suggest one reason why the value of g obtained might be slightly less than the accepte value of $9.81 ms^{-2}$?

Air resistance reduces acceleration slightly.

Light gates not perfectly aligned (increases measured time).

Timing delay in electronic circuit.

Discuss how you reduced the uncertainty in the measurement of the time taken for ball to fall through each distance from rest.

Regularly calibrate measuring instruments (like a stopwatch) to ensure accuracy.

Taking multiple measurements and calculating the average reduces the impact of random fluctuati

Use instruments with higher resolution (e.g., a stopwatch with milliseconds instead of seconds).

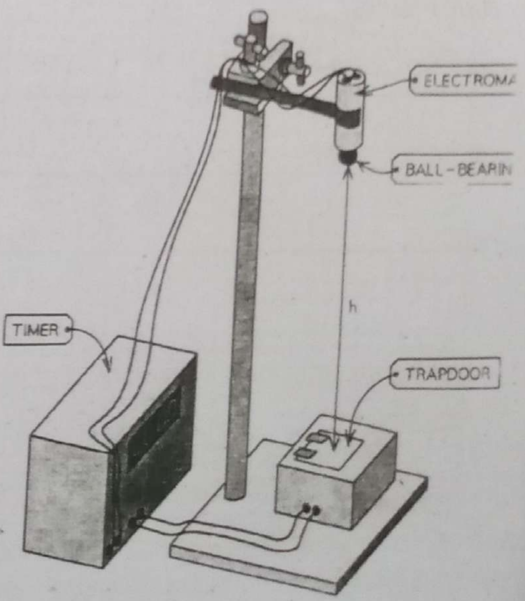
ACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER-

tudent is given the task to investigate the value of y free fall method using electronic timer as shown in gure. He adjusts the height of electromagnet to a le distance and attaches the iron ball with omagnet. He then cut off the power supply of omagnet and let the ball fall.

asures the distance and time of free fall.

peats the procedure by falling the same ball for different s and notes the values in the table as shown below.

Complete the column (1)



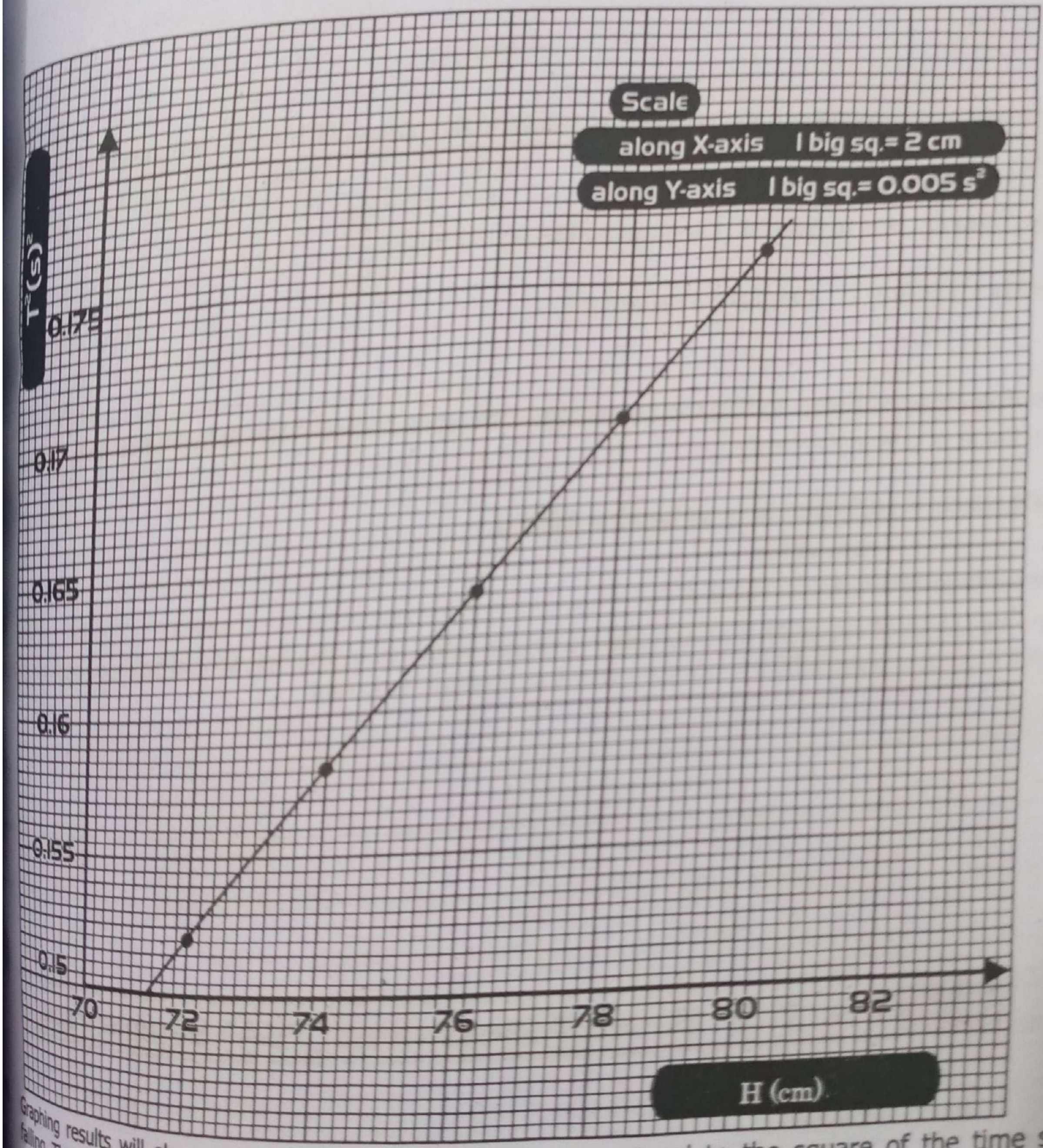
Sr	Height (h) cm	Time T (s)	h/T^2 $cm\,s^{-2}$
1	80	0.42	
2	78	0.41	
3	76	0.404	
4	74	0.397	
5	72	0.39	

Plot a graph of h (x-axis) and T^2 (y-axis). (2

Jsing the graph, discus how h and T^2 are related to each other? What conclusions can you draw /our results? (1)

Solution: Practical Based Assessment (PBA) Sample Paper- 1

No. Sr	Height (h) cm	Time T (s)	h/T^2 cm s^{-2}
1	80	0.42	453.5
2	78	0.41	464.0
3	76	0.404	475.0
4	74	0.397	462.5
5	72	0.39	473.3

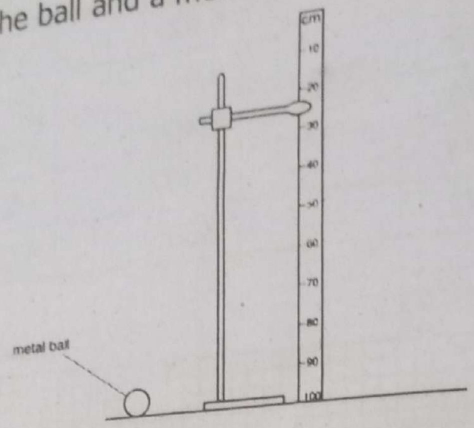


Graphing results will show that distance traveled is in proportional to the square of the time s falling. This explains the curve in the graph: because of the constant acceleration produced by force of gravity, the velocity of an object will get increasingly faster.

ACTICAL BASED ASSESSMENT

tudent measures the acceleration of free-fall g. He drops a metal ball from a height of 1 onto the floor, and measures the time t it takes to hit the floor.

Fig. 1.1 shows the ball and a metre rule, held vertically in a clamp



He repeats the experiment and obtains the following five values of t, measured in seconds.

65	0.60	0.60	0.68	0.59	0.61

e acceleration due to free-fall g is given by the equation $g=\frac{2h}{t_{av}^{2}}$

here h = 1.000m. Calculate a value for g.

g = ... m/s^2 (2)

Jse the equation below to find the percentage difference between the actual value of g, (9.8 ms^{-2}) the value of g you obtained:

ifference = (difference in values) × 100%
real value

Percentage difference in value of "g" = ... (1)

Another student suggests that, to obtain a better value for g, the ball should be dropped from a height greater than 1.000m. Explain why this student is correct. (1

olution: Practical Based Assessment (PBA) Sample Paper- 2

$$g=\frac{2h}{t_{av}^{2}}=\frac{2(1.000)}{(0.63)^{2}}=5.04\,ms^{-2}$$

51%

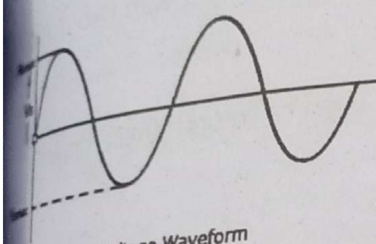
This student is correct because by dropping the ball from a greater height, it would take a longer time o fall which would reduce the effect of the human reaction error in timing.

PRACTICAL 4

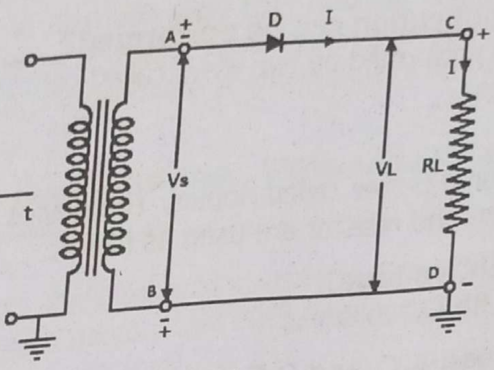
STUDY THE INPUT AND OUTPUT WAVEFORMS FOR HALF WAVE RECTIFICATION USING CRO.

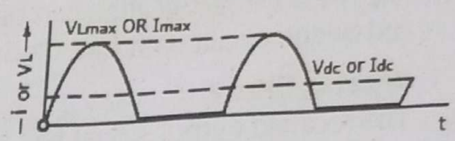
Apparatus

Power supply , transformer , Oscilloscope, Semiconductor diode , load resistor, DC voltmeter , AC voltmeter



Input Voltage Waveform





Rectified output Voltage/Current Waveform

Procedures

Make connections as shown in fig.

Connect the oscilloscope between points A and B and plot the waveform.

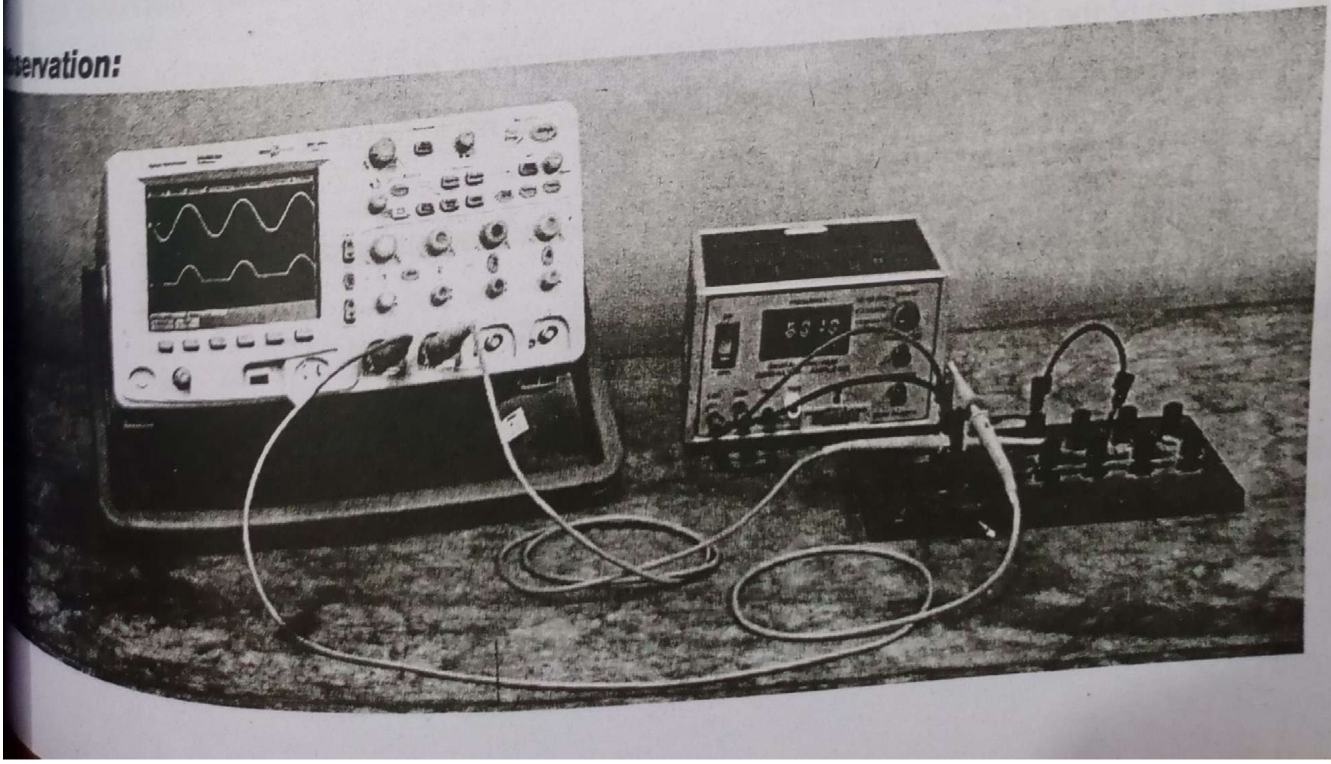
Measure AC voltage between points A and B (V_{rms}).

Connect the oscilloscope between pints C and D and plot the waveform.

Measure DC voltage between points C and D (V_{av}).

Plot the waveform.

bservation:



POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

1. What is rectification?
Ans. The conversion of AC signal into DC signal is called rectification.

2. What are types of rectification?
Ans. The rectification has two types called half wave rectification and full wave rectification.

3. What is half wave rectification?
Ans. The process in which diode conducts during one alternation of input cycle is called half wave rectification. The rectified out consists of either positive half cycles or negative half cycles. The sin diode connected in circuit can perform half wave rectification.

4. What is full wave rectification?
Ans. The conversion of AC input signal into DC output signal such hat both positive and negative half cy of input signal are utilized is called full wave rectification.

5. How many ways full wave rectification can be performed?
Ans. The full wave rectification can be performed by two ways called center-tapped circuit with two dio and bridge circuit with four diodes.

6. What is filter?
Ans. The rectified output signal has some pulses called ripples. The device used to smooth these ripples called filter. The capacitor, choke and resistor are used as filters.

7. Can transformer work with DC voltage?
Ans. The transformer can not work with DC voltage.

8. What is the difference between A.C. and D.C. currents?
Ans. Alternating current (A.C) is that current which changes its direction several times during one secon while direct current (D.C) does not change its direction and travels straight.

9. What is semiconductor diode (or p – n junction)
Ans. A silicon or germanium crystal formed such that one half of it is p – type material and the other hal n – type material is called a p – n junction or semiconductor diode.

10. What is ripple?
Ans. It is defined as the pulsations (or A.C. component) present in the output voltage supplied by a recti

11. What is meant by ripple factor?
Ans. The ratio of the effective value of the alternating component of current (or voltage) to the average D.C. component of output current (voltage) is known as ripple factor i.e. Voltage ripple factor $= \frac{V}{V}$

12. What do you understand by filter?
Ans. It is a circuit element which reduces the ripple present in output voltage of a rectifier.

13. What is filtration?
Ans. The process of reducing the ripple of a rectifier output is called filtration.

14. What is smoothing circuit?
Ans. It is circuit which absorbs the A.C. component from the rectified output and make it non – pulsating unidirectional current (or voltage)

15. How does a p – n junction rectify?
Ans. During one half of the A.C. input, p – n junction, being forward biased, offers a low resistance and allows he current to flow in the output circuit. During the other half of the cycle, the junction get reverse biased and offers a very large resistance due to which no current flows in the output

16. **Explain why the output waveform of half wave rectifier appears as "pulses" instead of a continuous sinusoid.**

Because the diode only conducts during positive half-cycles; negative half is blocked, leaving pulsed output.

17. **If the signal generator frequency is increased, how would the appearance of the half-wave rectified output on the CRO change, assuming the voltage setting (Y-gain) remains constant?**

The frequency of the pulses in the output will increase.

Explanation:

This is because the output frequency is equal to the input frequency for a half-wave rectifier a higher input frequency means a higher output ripple frequency, causing the pulses to appear closer together horizontally on the CRO screen.

The student notices that during the negative half-cycle of the input, the output trace on the CRO is a flat line at 0 V. Explain why this occurs, with reference to the diode.

The flat line at 0 V occurs because the diode is reverse-biased during the negative half-cycle. In this state, the p-n junction of the diode does not allow current to flow, so the potential difference across the output resistor is zero.

The student increases the load resistance. State and explain the change in the ripple voltage observed on the CRO.

The ripple voltage will decrease.

A larger load resistance reduces the discharge current of the capacitor between input peaks. According to , a larger R results in a larger time constant (RC), meaning the capacitor discharges more slowly, leading to a smaller drop in voltage (ripple).

The diode is now reversed. On the axes provided, sketch the new output waveform and explain why the shape changes.

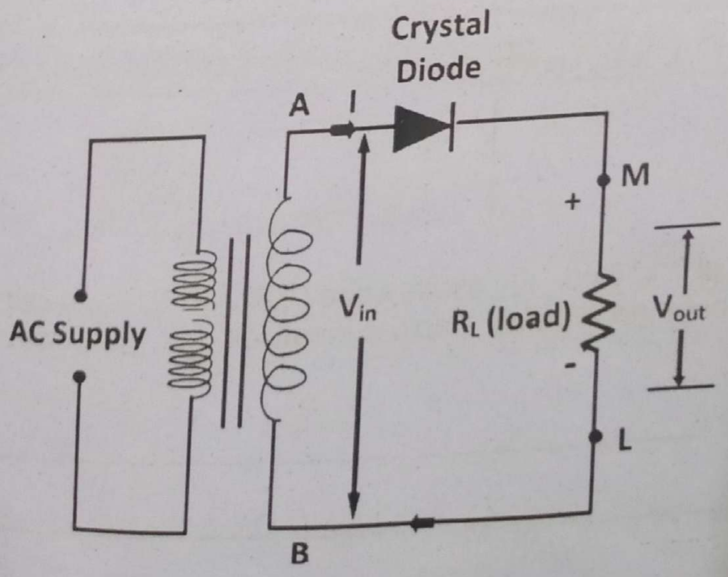
Sketch shows negative half-cycles only.

Explanation:

Reversing the diode makes it conduct during negative half-cycles, so output pulses are negative

RACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

ents connect a single diode in series with a 1 kΩ resistor to form a half-wave rectifier. They apply an AC ge of 10 V (peak) from a transformer and observe input and output waveforms on a CRO.



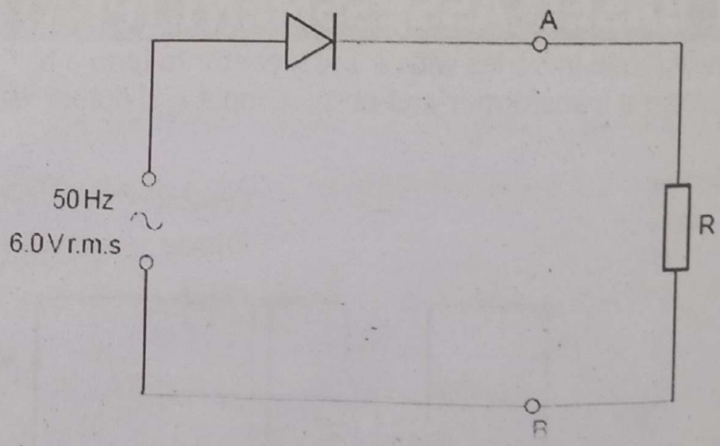
i. Sketch and describe the appearance of the input and output waveforms as seen on the CRO.

ii. Calculate the RMS value of the output voltage.

iii. The load resistor is 1 kΩ. Calculate the average power dissipated across the resistor.

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER-

Q A student sets up a half-wave rectifier circuit using a silicon diode. An alternating supply of frequency 50 Hz and having an output of 6.0 $V_{r.m.s}$. is to be rectified as to provide direct current for a resistor R. The circuit of Fig.I is used



The diode is ideal. The Y-plates of a cathode-ray oscilloscope (C.R.O.) are [illegible]ted between points A and

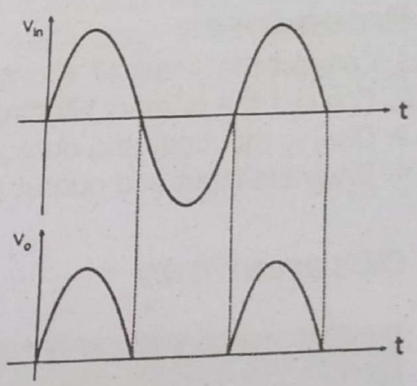
(i) Calculate the maximum potential difference across the diode during one cycle. [1]

Describe and explain the effect on the CRO trace if the diode is reversed in direction. [2]

Calculate the power dissipated in the resistor and state how it would change if the diode were reversed. [1]

Solution: Practical Based Assessment (PBA) Sample Paper- 1

Diode conducts only during positive half-cycles
During negative half-cycles, diode is reverse-biased and blocks current



$$V_{rms} = \frac{V_{peak}}{\sqrt{2}} = \frac{10V}{\sqrt{2}} = 7.07V$$

$$P = \frac{V_{rms}^2}{R} = \frac{(7.07V)^2}{1000\Omega} = 49.98\,mW$$

Solution: Practical Based Assessment (PBA) Sample Paper- 2

$$V_{rms} = \frac{V_{peak}}{\sqrt{2}}$$

$$V_{peak} = \sqrt{2}V_{rms} = \sqrt{2}(6V) = 8.48V$$

Output waveform shifts to display only negative half-cycles instead of positive
Because diode now conducts during negative half of the AC cycle and blocks positive

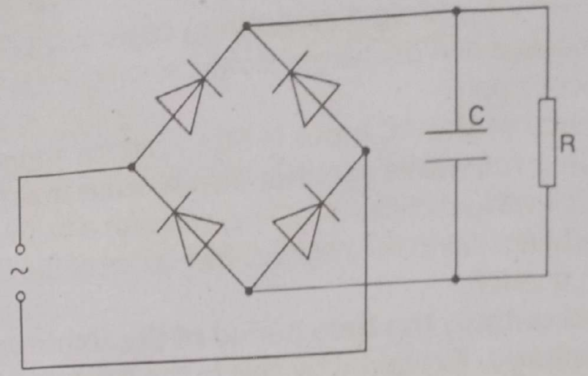
$$P = \frac{V_{rms}^2}{R} = \frac{(6V)^2}{1000\Omega} = 36\times10^{-3}W = 36\,mW$$

If diode is reversed, same magnitude of power dissipated since only phase inverted

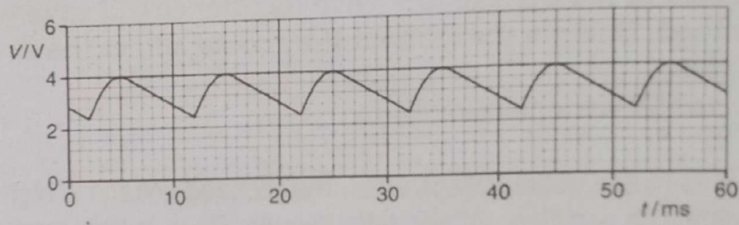
PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER

Q. A student investigates the full-wave rectification of a sinusoidal input signal.

A sinusoidal alternating voltage supply is connected to a bridge rectifier consisting of four ideal diodes. The output of the rectifier is connected to a resistor R and a capacitor C as shown in Fig. I.



The function of C is to provide some smoothing to the potential difference across R.
The variation with time t of the potential difference V_{across} the resistor R is shown in Fig. II.



Use Fig. II to determine, for the alternating supply,

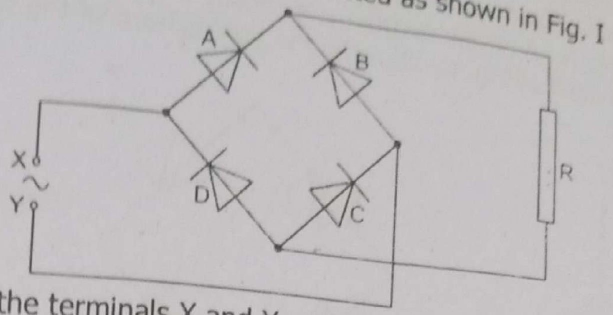
(i) The peak voltage

(ii) The root-mean-square (r.m.s.) voltage

(iii) The frequency. Show your working.

RACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

ge rectifier consists of four ideal diodes A, B, C and D, connected as shown in Fig. I



nating supply is applied between the terminals X and Y.

On Fig.I, label the positive (+) connection to the load resistor R.

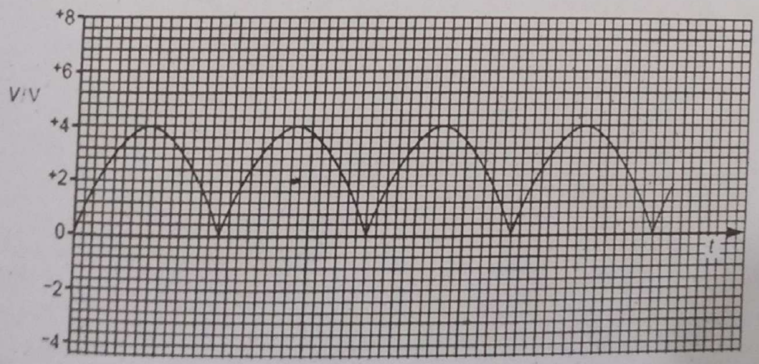
[1]

te which diodes are conducting when terminal Y of the supply is positive.

ode -----------and -----------diode

[1]

variation with time t of the potential difference V across the load resistor R is shown in Fig.II



d resistor R has resistance 2700Ω.

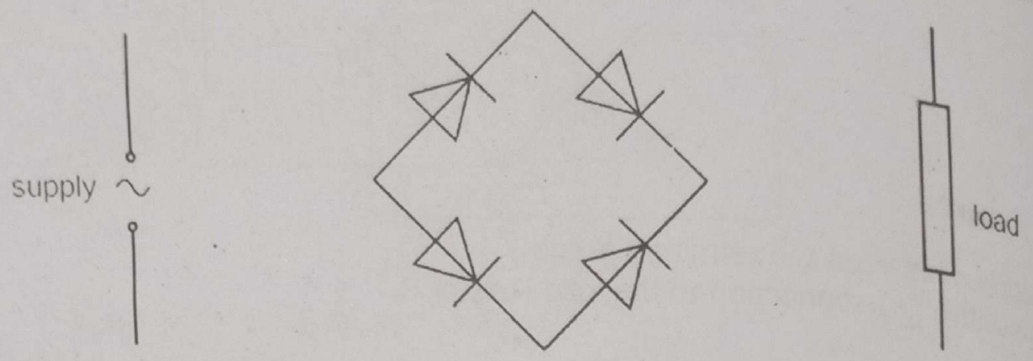
II to determine the mean power dissipated in the resistor R.

[2]

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PA

A student investigates full-wave rectification using a bridge rectifier (four diodes) and a AC sour to a load. The input and output waveforms are displayed on a CRO for analysis.

(i) The components for a bridge rectifier are shown in Fig
Complete the circuit of Fig. by showing the connections of the supply and of the load to th



(ii) The student measures the peak voltage of the output waveform to be 7.1 V. Calculate th across the load resistor.

(iii) Suggest one modification to obtain a smoother DC output and explain how it works.

Solution: Practical Based Assessment (PBA) Sample Paper- 1

Peak voltage = 4.0 V

$$V_{rms}=\frac{V_o}{\sqrt{2}}=\frac{4V}{\sqrt{2}}=2.8V$$

Period $T=20\,ms$

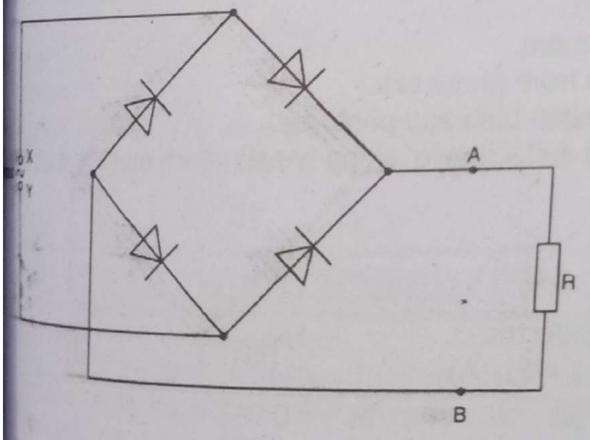
Frequency= $f=\frac{1}{T}=\frac{1}{20\times10^{-3}s}=50Hz$

Solution: Practical Based Assessment (PBA) Sample Paper- 2

(i) connection to 'top' of resistor labelled as positive
(ii) diode B and diode D

$$P=\frac{V_{rms}^2}{R}=\frac{1}{2}\left(\frac{V_{peak}^2}{R}\right)=\frac{1}{2}\left(\frac{(4V)^2}{2700\Omega}\right)=2.96\times10^{-3}W$$

Solution: Practical Based Assessment (PBA) Sample Paper- 3



$$V_{rms}=\frac{V_o}{\sqrt{2}}=\frac{7.1V}{\sqrt{2}}=5.02V$$

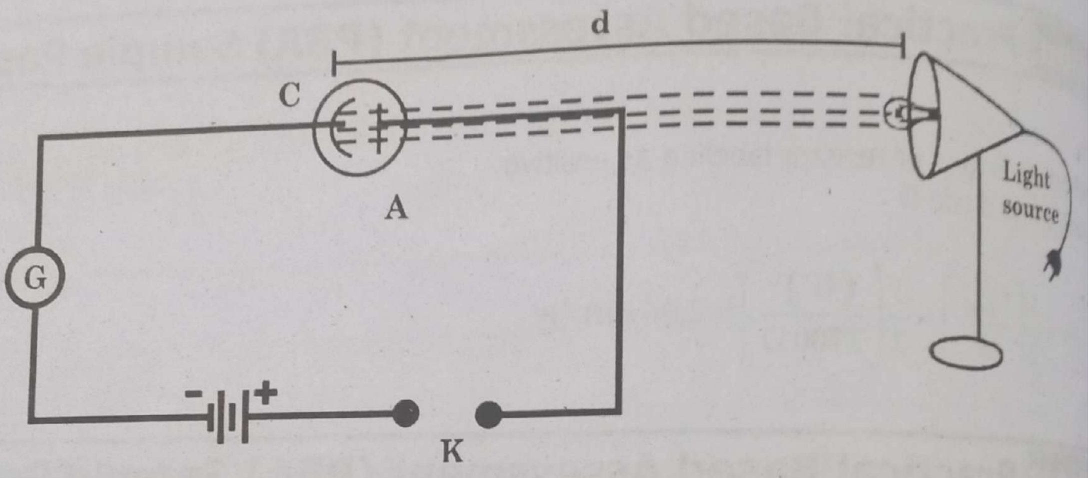
Add a capacitor across the load
It charges during peaks and discharges between peaks, smoothing voltage variations.

PRACTICAL 6

TO STUDY VARIATION OF ELECTRIC CURRENT WITH INTENSITY OF LIGHT USING PHOTOELECTRIC APPARATU

Apparatus:

Photocell, Battery, Electric lamp, Key, Micro-ammeter, Bulb

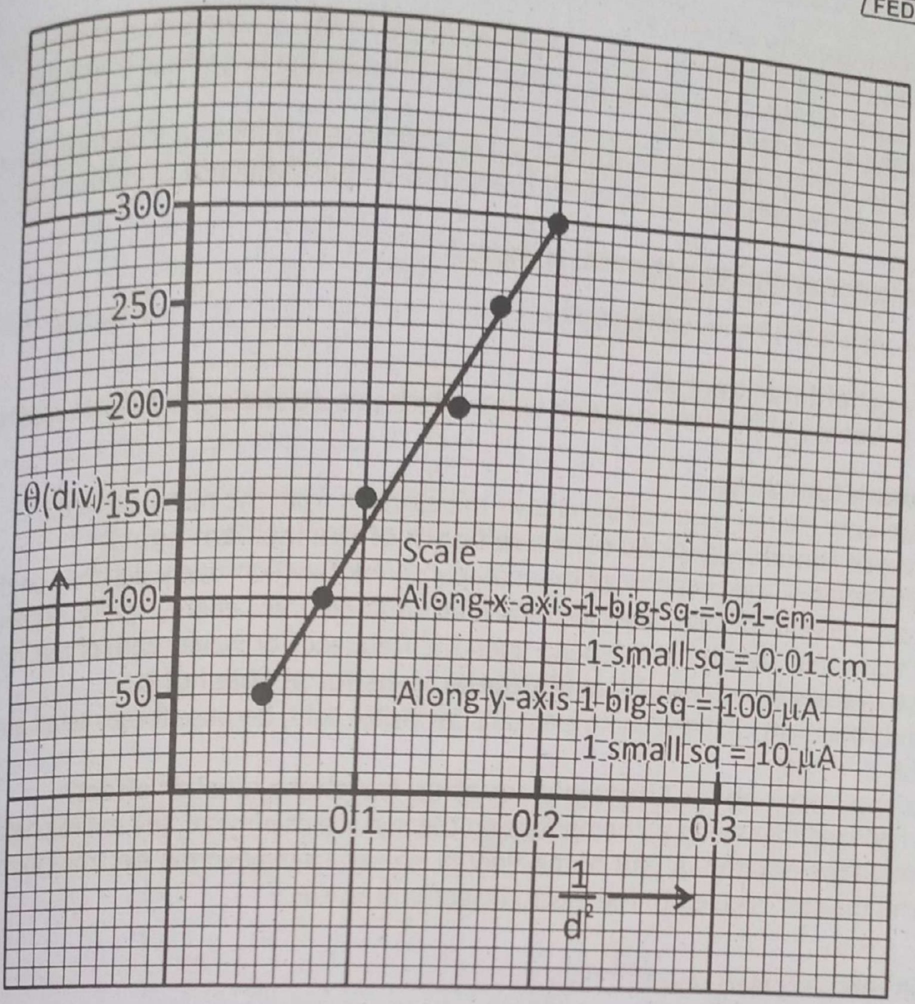


Procedure:

1. Make connections according to the circuit diagram.
2. Observe different readings by displacing bulb from photo cell.
3. Measure distance with meter rod placed between bulb and photo cell.
4. Plot a graph between '$1/d^2$' along x-axis and deflection 'q' along y-axis which must be a st

Table:

No. Of Obs.	Distance of Photocell from the bulb d (cm)	Photo electric Current I = (μ A)	$\frac{1}{d^2}\left(cm^{-2}\right)$	$I/\theta=$
1	21	50	0.047	
2	14	100	0.071	
3	9	150	0.111	
4	7	200	0.142	
5	6	250	0.166	
6	4	300	0.25	



rence:

he graph between $1/d^2$ and q is a straight line, this shows that photoelectric current varies y to the intensity of incident light.

POST LAB QUESTIONER/PRACTICE SHORT QUESTIONS

What is photoelectric effect?

When light of suitable frequency falls on metal surface, electrons are emitted from the metal surface. phenomenon is known as photoelectric effect and electrons emitted by this effect are called as photoelectrons.

What are the characteristics of the Photoelectric Effect phenomenon?

The photoelectric current is directly proportional to the light intensity.

The kinetic energy of the photoelectrons is directly proportional to the light frequency.

The stopping potential is directly proportional to the frequency, and the process is instantaneous.

The threshold frequency varies with the material; it is different for different materials.

What Factors affects the Photoelectric Effect phenomenon?

- Frequency of incident radiation
- The intensity of incident radiation
- A potential difference between the metal plate and collector

4. **What is the intensity of light?**
Ans: The intensity of light refers to the amount of energy that a light wave carries per un direction perpendicular to that area. It is often described as the brightness of the light.

5. **What is stopping potential?**
Ans: It's the voltage difference required to stop the ejection of electrons and stop their movemen the plates. Stopping potential is negative. It depends on the frequency of incident radiation bu its intensity.

6. **For which color stopping potential is more?**

Blue, since it's has minimum wavelength.

$$\uparrow E_{incident} = hf = \frac{hc}{\lambda \downarrow}$$

7. **Define threshold frequency?**
Ans: Minimum frequency of incident radiation below which photoelectric effect is not possible.

8. **What is work function?**
Ans: It's the minimum energy required to remove the electron from the metal surface.

9. **Can the work function depend on wavelength of the incident light?**
Ans: The work function is the property of the material. Work function solely depends on the materia metal used. Different metals have electrons present at different energy levels, depending on wh work function varies. It does not depend upon the frequency or wavelength of the incident light

10. **Name the metals which emit the photoelectrons for visible light.**
Ans: Sodium and Potassium emit the photo electrons for visible light, because these metals are very sensi visible light.

11. **What do you know about Einstein's equation for photo electric effect?**
Ans: Einstein theorized that when a photon falls on the surface of a metal, the entire photon's energy transferred to the electron. A part of this energy is used to remove the electrons form the metal surface and the rest is given to the ejected electrons as K.E.

$$hf = KE_{max} + \phi$$

12. **Define inverse square law?**
Ans: Inverse square law states that:
"The intensity of the radiation is inversely proportional to the square of the distance from the so light".

13. **What is a photo cell?**
Ans: Photo cell is a device which converts light energy into electrical energy under certain conditions.

14. **Why inert gases are filled photocell?**
Ans: Inert gases like neon, argon are filled inside the cell to increase the ionization and thereby increas photoelectric current.

15. **What are the used of photo cell?**
Ans: The photo cells can be used in the situations where a beam of light falling on a cell is broken. So they can be used as (i) Counting machine, (ii) Burglar alarms (iii) Automatic switching of s lighting circuit (iv) Automatic door opener (v) Fire alarms and in film industry used for the rec and reproduction of sound.

16. **What is the difference between solar cell and photocell?**
Ans: A solar cell produces power for an electrical circuit while a photocell is a light- activated control s

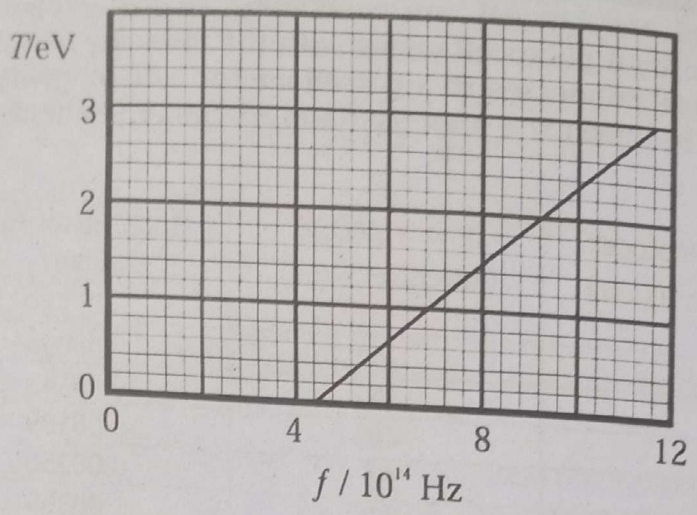
ACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 1

Two students, Asad and tanzeel, are conducting an experiment to investigate how the ic current generated by a photocell varies with the intensity of light. They use a lamp as a source and a photocell connected to a galvanometer. The intensity of light is controlled by ing the distance d between the photocell and the lamp filament. The data they collect is n in the table.

No. Of Obs.	Distance of Photocell from the bulb $d\left(cm\right)$	Photo electric Current θ $\left(\mu A\right)$	Intensity of light $I=\frac{cons\tan t}{d^2}\left(cm^{-2}\right)$	$\frac{I}{\theta}\approx cons\tan t$
1	32	25	0.00098	3.92×10^{-5}
2	26	35	0.00148	4.22×10^{-5}
3	23	48	0.00189	3.93×10^{-5}
4	20	60	0.00250	4.16×10^{-5}
5	18	70	0.00309	4.41×10^{-5}
6	16.5	85	0.00367	4.31×10^{-5}
7	15.3	95	0.00428	4.50×10^{-5}

t a graph of electric current θ (in μA) against the intensity of light $\frac{1}{d^2}$ using the provided data. And ain the trend of graph (02)

ii. The graph shows how the maximum kinetic energy T of photoelectrons emitted from the surface of so metal varies with the frequency f of the incident radiation.



(a) Why are no photoelectrons emitted at frequencies below $4.4\times10^{14}\,Hz$?

(01)

(b) Calculate the work function ϕ of sodium in eV?

(01)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER- 2

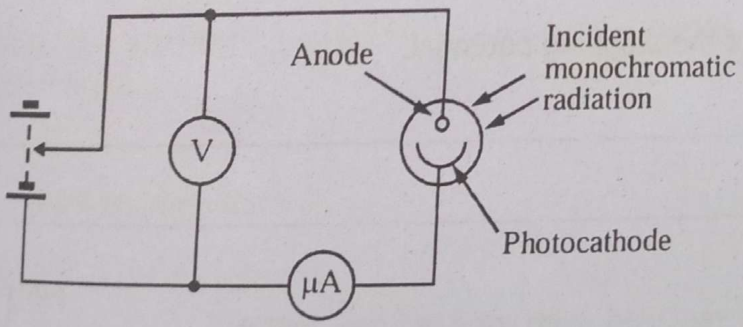
Two students, Abdullah and Hamza, are investigating the relationship between the electric current generat by a photocell and the intensity of light. They alter the distance between the light source and the photocell t change the intensity and record their results. Their goal is to evaluate the linearity of the relationship an explore the theoretical implications of their observations.

No. Of Obs.	Distance of Photocell from the bulb $d\,(cm)$	Photo electric Current θ (μA)	Intensity of light $I=\frac{cons\tan t}{d^2}(cm^{-2})$	$\frac{I}{\theta}\approx cons\tan t$
1	35	20	0.00082	4.10×10^{-5}
2	29	30	0.00119	3.96×10^{-5}
3	25	45	0.00160	3.55×10^{-5}
4	21	55	0.00227	4.12×10^{-5}
5	18.5	70	0.00292	4.17×10^{-5}
6	17	82	0.00346	4.21×10^{-5}
7	15.8	95	0.00400	4.21×10^{-5}

i. Plot a graph of electric current θ (in μA) against the intensity of light $\frac{1}{d^2}$ using the provided data. And explain the trend of graph

(02)

e diagram shows monochromatic light falling on a photocell. As the reverse potential difference etween the anode and cathode is increased, the current measured by the micro ammeter decreases. hen the potential difference reaches a value $V_{stopping}$; called the stopping potential, the current is zero.

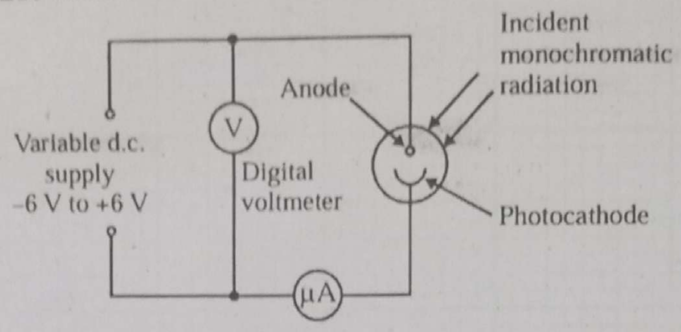

Anode
Incident monochromatic radiation
V
Photocathode
μA

uld be the effect on the stopping potential of
sing only the intensity of the incident radiation (01)

b) Increasing only the frequency of the incident radiation? (01)

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER-3

The diagram shows monochromatic radiation falling on a photocell connected to a circuit. The incident radiation has a wavelength of 215 mm. The metal surface of the photocathode has a work function of 2.26

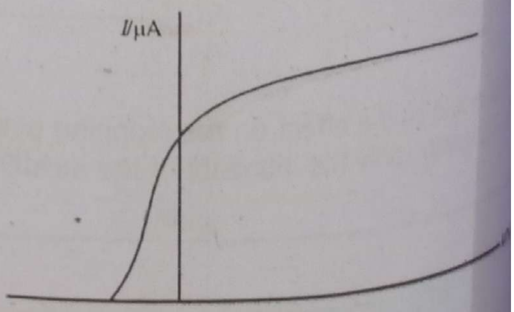

Incident monochromatic radiation
Anode
Variable d.c. supply -6 V to +6 V
V
Digital voltmeter
Photocathode
μA

i. Calculate the energy in eV of a photon of the incident radiation. (1)

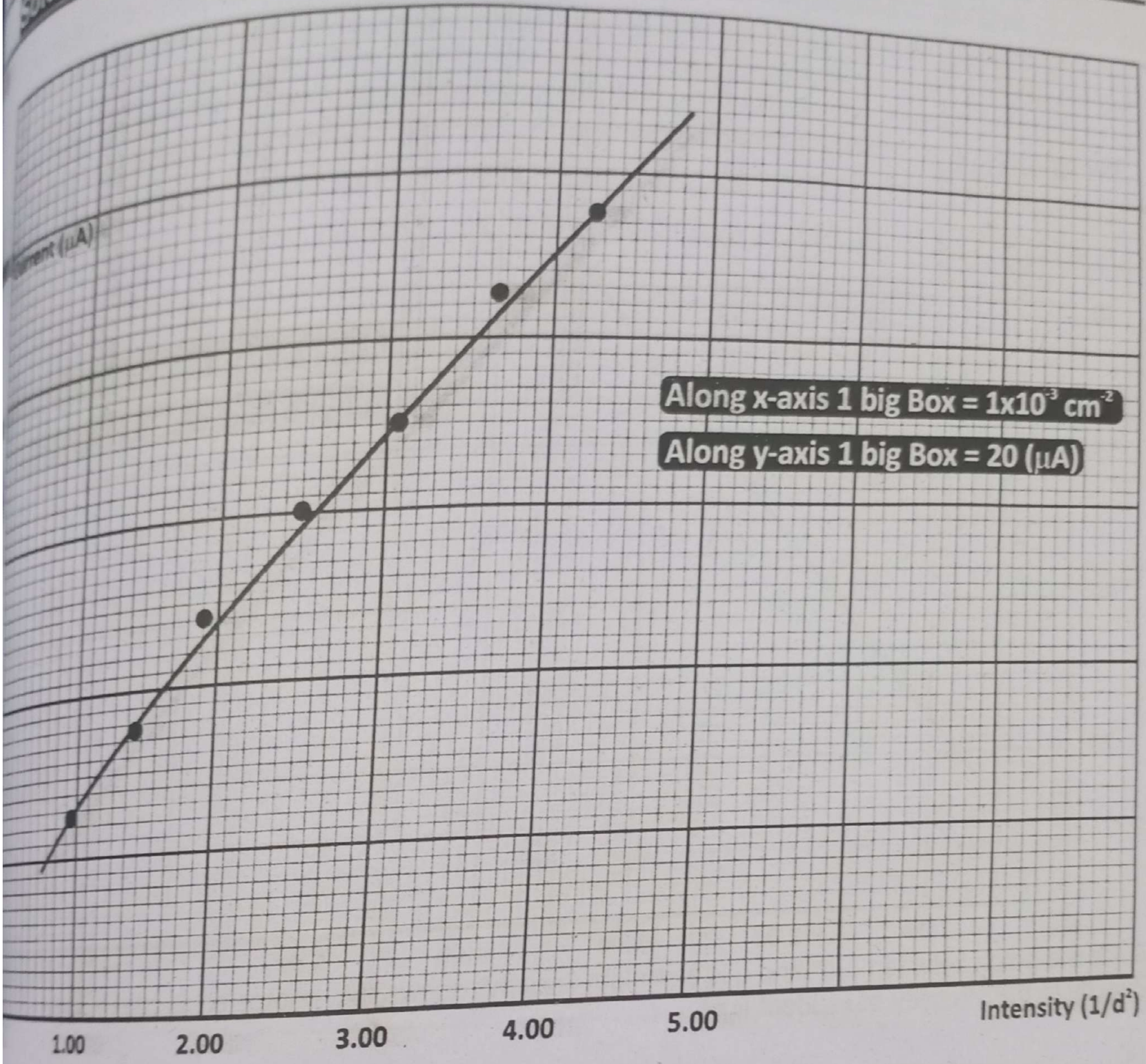
ii. What is the maximum kinetic energy in eV of the emitted electrons? (1)

iii. Write down the value of the stopping potential. (1)

iv. The photocathode is replaced with one whose metal surface has a greater work function. On the graph above, sketch how I would vary with V given that the wavelength and intensity of the incident radiation remain unchanged. (1)



Solution: Practical Based Assessment (PBA) Sample Paper- 1



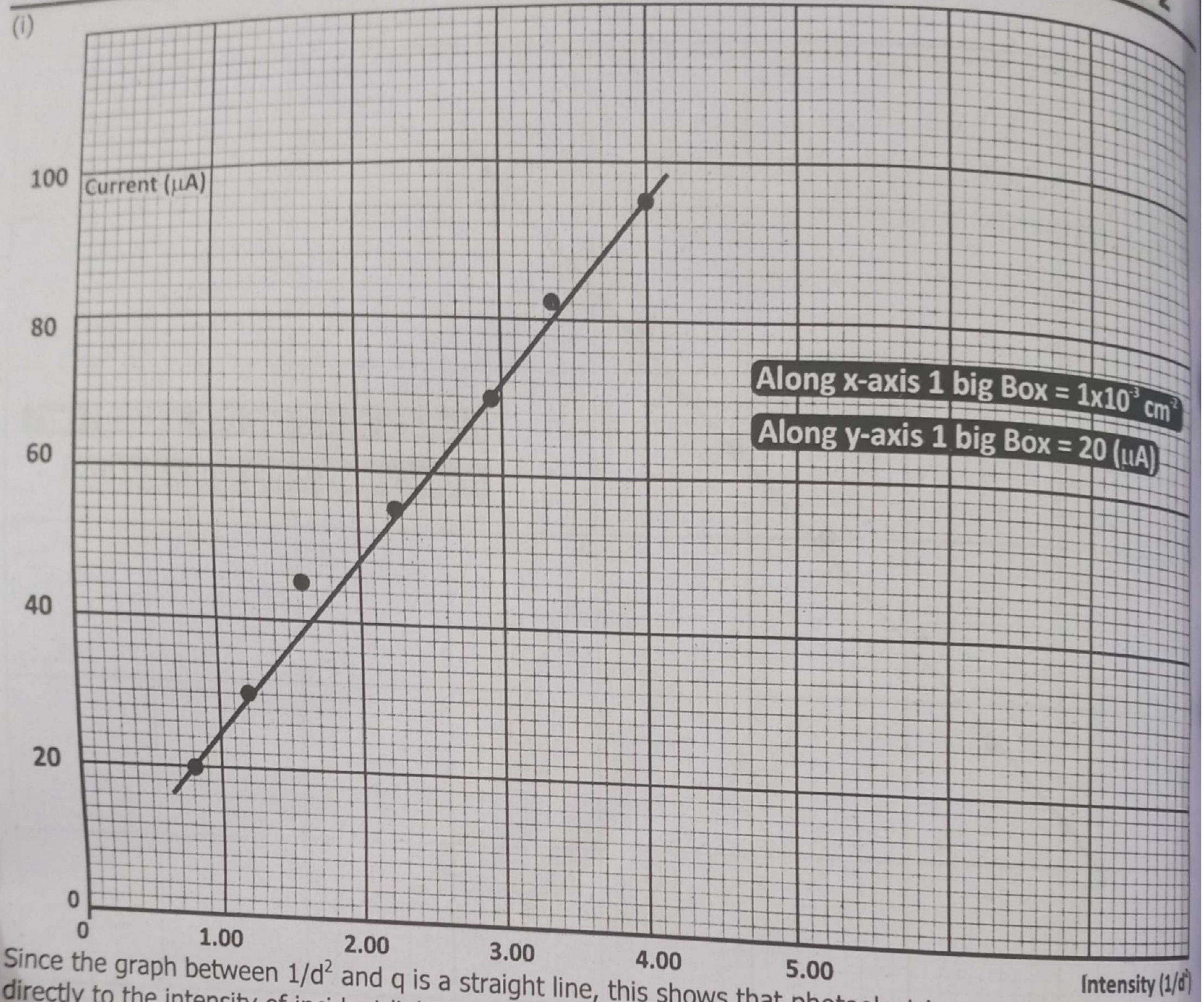
graph between 1/d^2 and q is a straight line, this shows that photoelectric current varies to the intensity of incident light.

a) Photon energy is too small/less than ϕ

b) $\phi = hf_o = (6.63\times10^{-34}\,Js)(4.4\times10^{14}\,Hz)\left[\dfrac{1eV}{1.6\times10^{-19}\,J}\right] = 1.82\,eV$

Solution: Practical Based Assessment (PBA) Sample Paper- 2

(i)



Since the graph between $1/d^2$ and q is a straight line, this shows that photoelectric current varies directly to the intensity of incident light.

(ii)

(a) When increasing only the intensity of the incident radiation, there is no effect on results

(b) When increasing only the frequency of the incident radiation, there is increases stopping potential

Solution: Practical Based Assessment (PBA) Sample Paper- 3

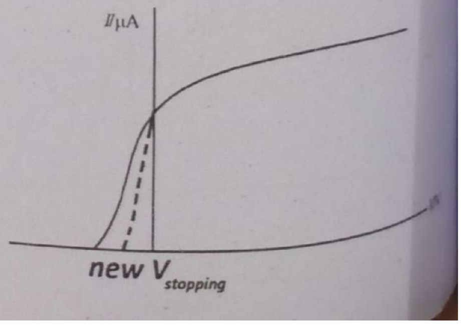
(i) $E=\frac{hc}{\lambda}=\frac{\left(6.63\times10^{-34}\,Js\right)\left(3\times10^{8}\,ms^{-1}\right)}{215\times10^{-3}\,m}\left[\frac{1eV}{1.6\times10^{-19}\,J}\right]=5.78\,eV$

(ii) $KE_{\max}=hf-\phi=5.78\,eV-2.26\,eV=3.52\,eV$

(iii) $KE_{\max}=eV_{stopping}$

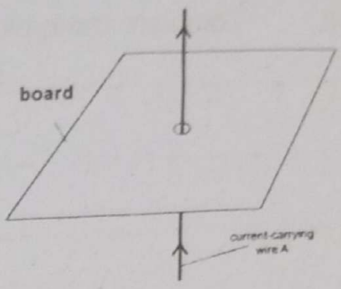
$V_{stopping}=3.52V$

iv.



SECTION B 40% : Marks 12

PRACTICAL BASED ASSESSMENT (PBA) SAMPLE PAPER



A student investigates the magnetic field around a long, straight al wire that carries a steady current. The wire is fixed through a ntal wooden board. A small magnetic compass is used to map the tion of the magnetic field in the plane of the board at several points d the wire.

the directions you measured and sketch the magnetic field pattern around e wire. (1)

the right-hand rule, state the direction of the magnetic field when current is upward. (1)

n why the magnetic field lines are circular and why field strength changes with distance from the (1)

ould the compass readings change if student doubled the current? Explain. (1)

Q-2 A student investigates the acceleration due to gravity by releasing a steel ball by an electromagnet. When the electromagnet is switched off, the ball falls vertically throu known height h, and an electronic timer records the fall time t. The procedure is repeated different heights.

(i) Complete the table by calculating the missing value of g? (1)

Sr. No.	Height (h) m	Time (t) s	g=?
1	0.300	0.248	
2	0.400	0.286	
3	0.490	0.316	

(ii) Plot a graph of h (x-axis) and T^2 (y-axis). (2)

(iii) The students plan to plot a graph of h against t. Explain why this is not a suitable graph for determining g and state what they should plot instead. (1)

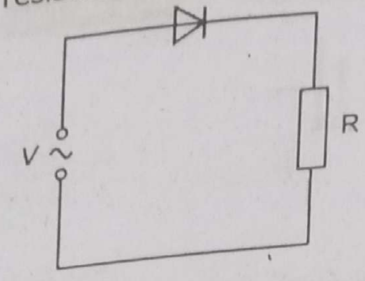
The output potential difference (p.d.) of an alternating power supply is represented by

$V = 320\sin(100\pi t)$

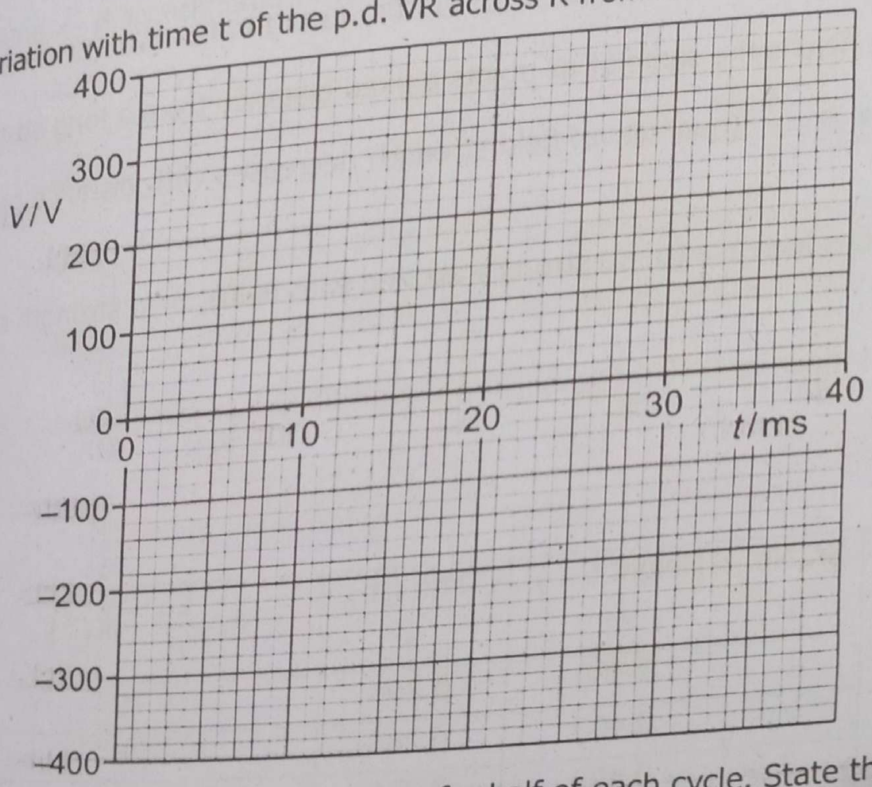
V is the p.d. in volts and t is the time in seconds.

Determine the period T of the output. [1]

The power supply is connected to resistor R and a diode in the circuit shown in Fig. I.



g. II sketch the variation with time t of the p.d. VR across R from time t = 0 to time t = 40 ms. [2]

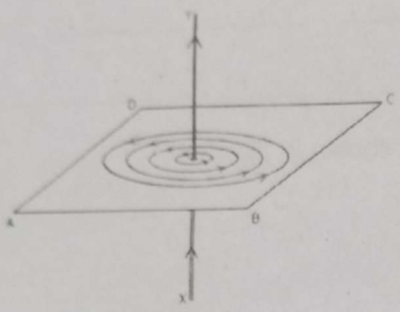


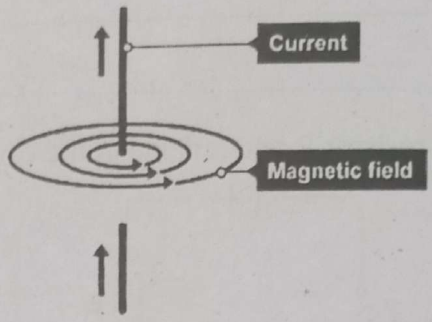
he student observes the output waveform is zero for half of each cycle. State the physical reason for his within the diode. (1)

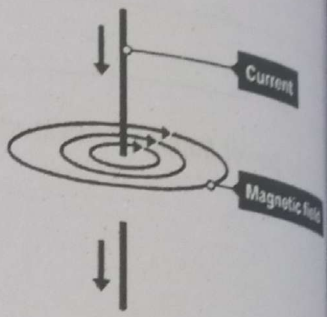
Solution: Practical Based Assessment (PBA) Test

Q1

i. Magnetic field lines are concentric circles around the wire. If current flows upwards, field direc anticlockwise when viewed from above (or to the right of the wire at front-east point, etc.). If cu downwards, direction reverses.







ii. Right-hand rule

Thumb points in direction of current (up); fingers curl in direction of B → anticlockwise when vie from above.

iii. By symmetry, the field is the same at all points a fixed distance from a long straight wire → circula

Magnitude falls as $B \propto \frac{1}{r}$ (qualitative: field strength decreases with distance because field lines sp out)

iv. Compass deflections increase (more strongly aligned with field); field strength doubles (linear with

Q2

(i)

Sr. No.	Height (h) m	Time (t) s	$g = \frac{2h}{t^2}\ (ms^{-2})$
1	0.300	0.248	9.76
2	0.400	0.286	9.78
3	0.490	0.316	9.81

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SECTION B

Investigate the value of ‘g’ by free fall method using electronic timer.

of obs.	Height (h) (cm)	Time (s) t_1	Time (s) t_2	Average (t) (s)	$g = \frac{2h}{t^2}$ (m/s²)
	28	0.24	0.22	0.23	10.59
	47	0.31	0.29	0.30	10.44
	67	0.37	0.38	0.375	9.53
	72	0.39	0.40	0.395	9.23
	76	0.40	0.42	0.41	9.04
	80	0.44	0.41	0.425	8.86

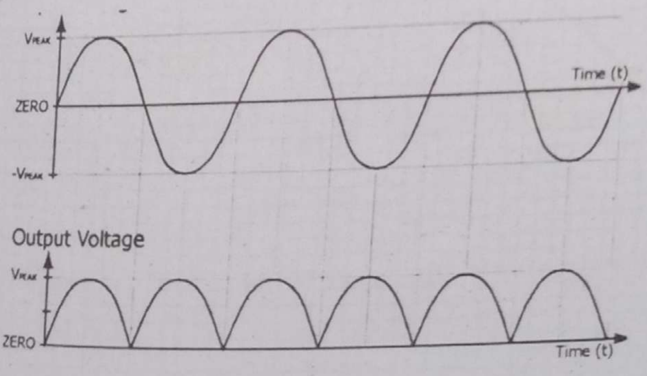
$$g_{mean} = \frac{10.59+10.44+9.53+9.23+9.04+8.86}{6} = 9.62\,ms^{-2}$$

$$percentage\,error = \left|\frac{\tau_{calculated} - \tau_{standard}}{\tau_{standard}}\right| \times 100$$

$$percentage\,error = \left|\frac{9.62-9.8}{9.8}\right| \times 100 \approx 1.94\%$$

he steel ball can be magnetized in this experiment by using an electromagnet in the setup. he ball is held in place by the electromagnet, which induces temporary magnetism in the steel ball to old it before release. When the current is switched off, the ball demagnetizes and falls freely.

rcuit shows a rectifier bridge connected to an AC supply. The terminals P and Q are ed to CRO circuit.



$$V_{rms} = \frac{V_{peak}}{\sqrt{2}} = \frac{8}{\sqrt{2}} = 5.657\,V$$

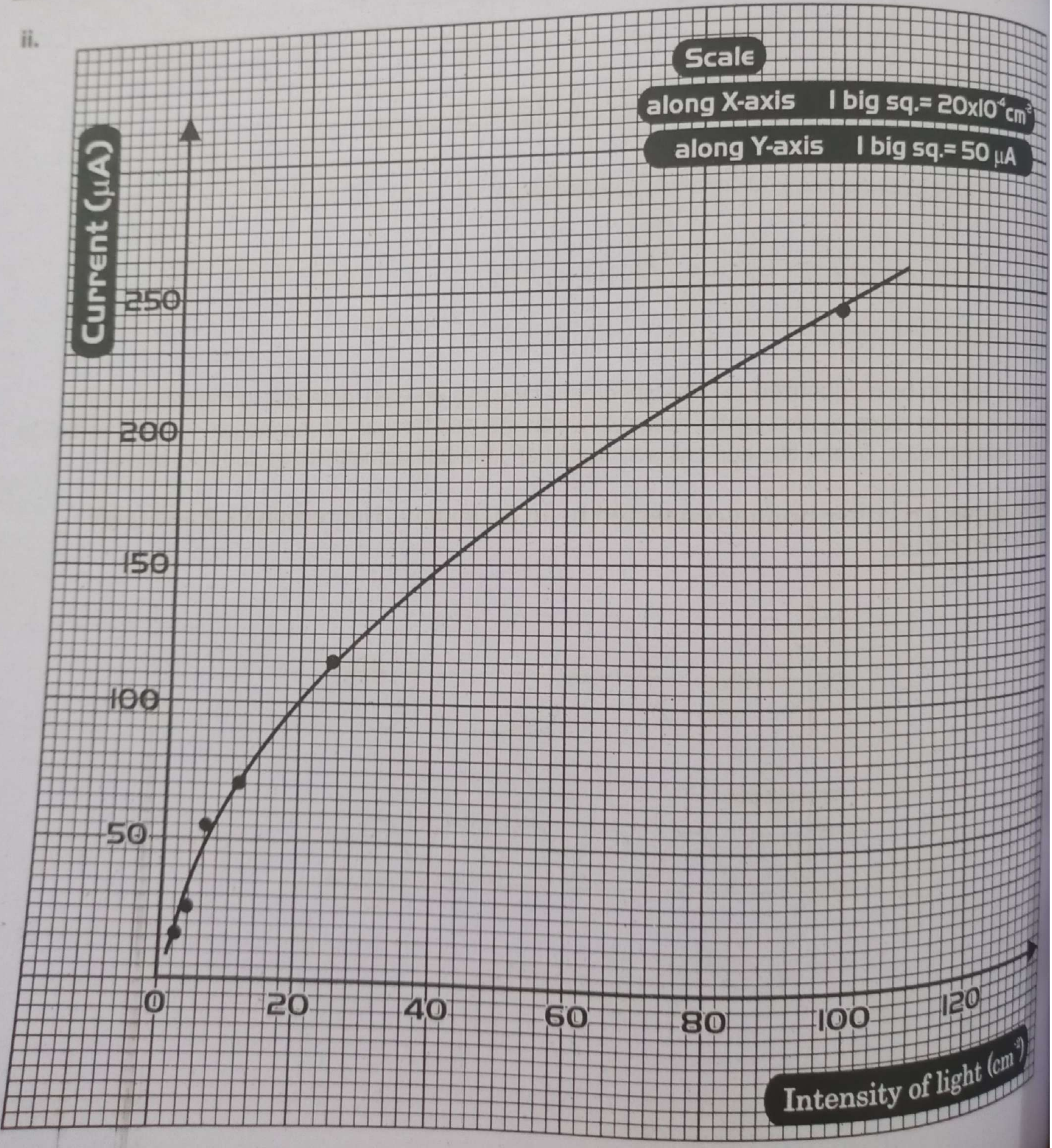
$$P = \frac{V_{rms}^2}{R} = \frac{(5.657V)^2}{4\Omega} \approx 8W$$

Q.6. To study variation of electric current with intensity of light using photoelectric appara

i.

No. of obs	Distance (d) (cm)	Current (I) (μA)	Intensity of light $\frac{1}{d^2}$ (cm^{-2})
1	60	15	0.000278
2	50	25	0.000400
3	40	55	0.000625
4	30	70	0.001111
5	20	115	0.002500
6	10	240	0.010000

ii.



TION FBISE (PBA) MODEL PAPER

SECTION A

Marks 30

potentiometer is used to determine the internal resistance of a cell in the lab.

nciple behind using a potentiometer is that the potential difference across any portion of a wire orm cross-section is directly proportional to the length of that portion, provided a constant nt flows through the wire

$$V \propto \ell$$

entiometer is preferred because at the null point, it draws no current from the cell. This allows accurate measurement of the EMF and terminal voltage

esistance R	Length of balance point without R (ℓ_1)	Length of balance point with R (ℓ_2)	Difference of lengths $\ell_1 - \ell_2$	Internal resistance $r = R\left(\frac{\ell_1 - \ell_2}{\ell_1}\right)$
Ω	m	m	m	Ω
3	223		97	
5	236		56	
7	227		31	

whose EMF is to be measured is connected in the secondary circuit. The jockey is moved along ntiometer wire until the galvanometer shows zero deflection. The length ℓ_1 from the zero end alance point is noted.

F of the cell $E = \left(\frac{\ell_1}{L}\right)V$

is the potential difference across the entire length L of the potentiometer wire, maintained by cell.

shows a spherometer used to measure radius of curvature of a convex surface

$$\text{Least count} = \frac{pitch}{no.of\ division\ on\ circular\ scale} = \frac{1mm}{100} = 0.01mm = 0.001cm$$

Circular scale reading b (cm)		Total reading = a + b (in cm)
Circular scale division touching the edge of the main scale	Circular scale division × least count (in cm)	
63	0.063 cm	0.263 cm

f spherical surface h = total reading on convex surface - mean height on plane glass plate
= 0.263 cm - 0.242 cm = 0.021 cm

ance between any two outer legs is the side of the equilateral triangle, so perimeter is 3 times ance.

er of equilateral triangle formed by the legs = 3 × side length = 3 × 4 cm = 12 cm.

$$R = \frac{\ell^2}{6h} + \frac{h}{2} = \frac{(4\,cm)^2}{6(0.021\,cm)} + \frac{(0.021\,cm)}{2} \approx 127\,cm$$

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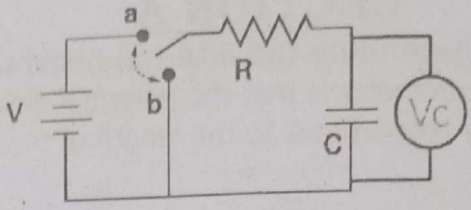
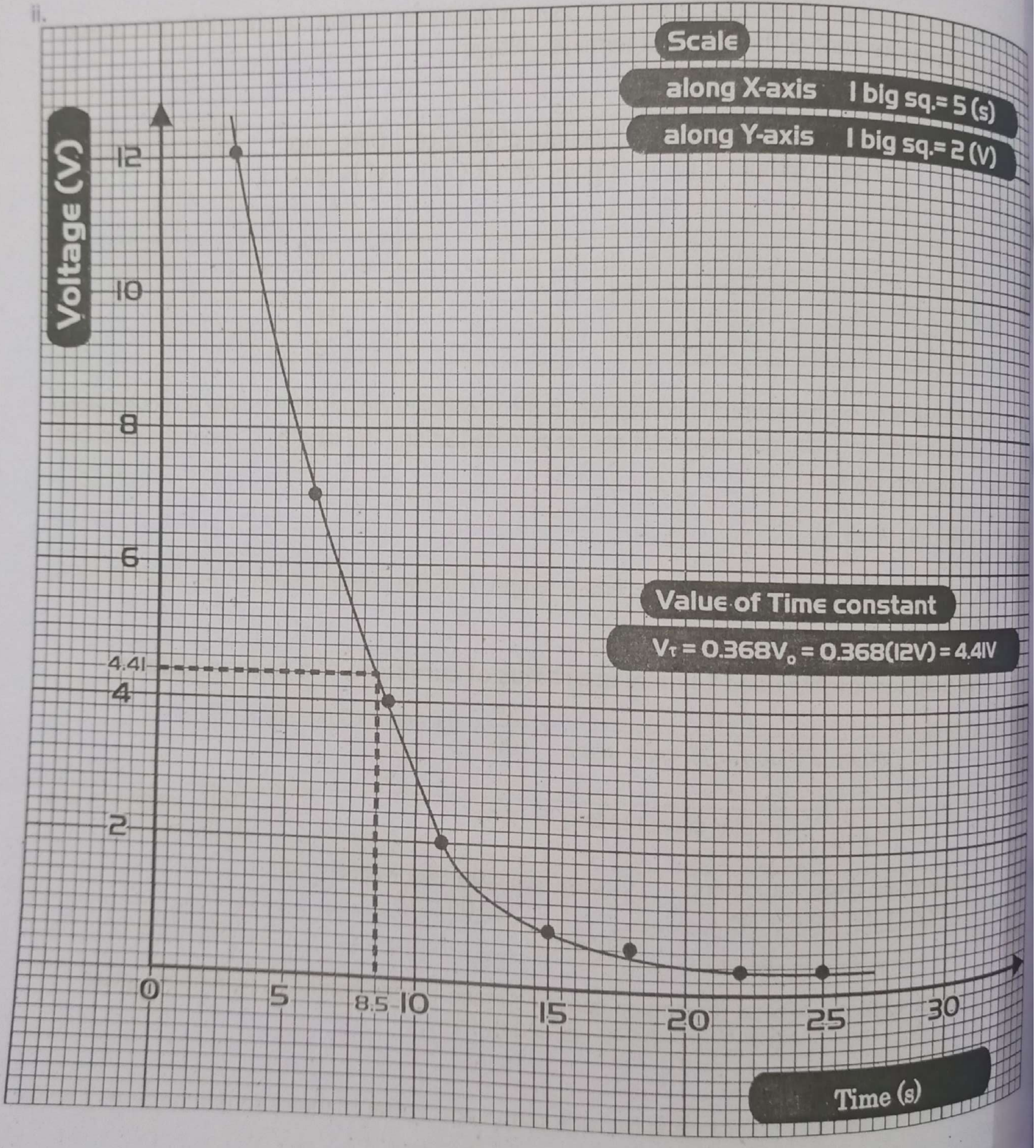
Q.3. Study the charging and discharging of a capacitor through a resistor and calculate th constant.

i.



ii.



iii.

$$\tau_{actual} = RC = (20000\Omega)(400\times10^{-6}F) = 8\,s$$

$$percentage\ error = \left|\frac{\tau_{graph} - \tau_{actual}}{\tau_{actual}}\right| \times 100 = \left|\frac{8.5-8.7}{8.7}\right| \times 100 = 2.29\%$$

Now it is placed on a convex surface. The distance between any two outer legs is 4 cm.

n scale ing a	Circular scale reading b (cm)		Total reading = a + b (in cm)
	Circular scale division touching the edge of the main scale	Circular scale division × least count (in cm)	
m (--- cm)	63		

Copy and complete the table. (01)

Calculate height of spherical surface. (01)

Find the perimeter of equilateral triangle formed by the legs of spherometer. (01)

What is the radius of the curvature of the spherical surface? (02)

3. **Study the charging and discharging of a capacitor through a resistor and calculate the time constant.**

A student aims to calculate the time constant for a capacitor which is marked as 400 μF. He connects a 20 KΩ resistor and a battery of 12 V in series with the capacitor. He also connects a voltmeter in parallel with the capacitor and a two-way switch to charge and discharge the capacitor. Table below shows the values obtained when the capacitor was discharged from its peak voltage.

Time (s)	3	6	9	11	15	18	22	25
Voltage (V)	14	7	4	2	0.8	0.6	0.3	0.3

raw the circuit diagram of the experimental arrangement. (01)

Draw a graph from the given values and also determine the time constant from this graph. (03)

What is the actual value of the time constant? Also calculate the percentage error in your calculated time constant.

SECTION B (4 × 3 = 12)

4. **Investigate the value of 'g' by free fall method using electronic timer.**

With the help of electronic timer, students measure the distance and time of free fall by repeating procedures with same steel ball for different heights and recorded readings given in following table.

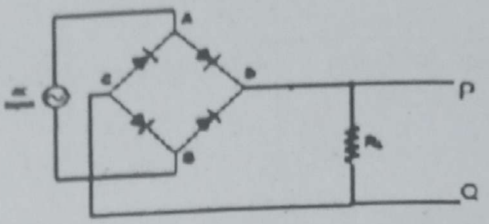
i. Copy and complete the table. (02)

. of obs.	Height (h) (cm)	Time (s) t_1	Time (s) t_2	Average (t) (s)	$g = \frac{2h}{t^2}$ (m/s²)
1	28	0.24	0.22		
2	47	0.31	0.29		
3	67	0.37	0.38		
4	72	0.39	0.40		
5	76	0.40	0.42		
6	80	0.44	0.41		

Calculate the mean value of g and percentage error in g. (01)

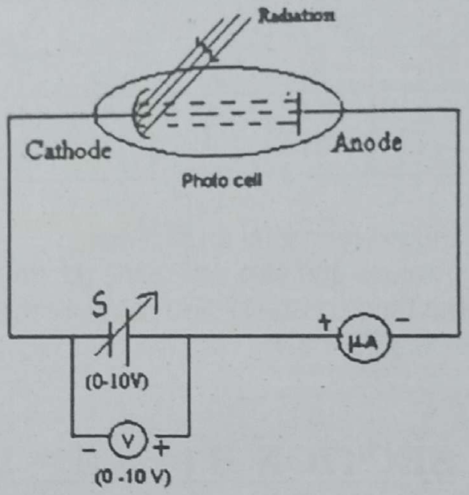
How can we magnetize steel ball in this experiment? (01)

Q.5. A circuit shows a rectifier bridge connected to an AC supply. The terminals P and Q
connected to CRO circuit.



i. Draw the waveform obtained at output PQ.
ii. At output PQ (from CRO) peak value of voltage 'V' is 8V. What is its r.m.s value?
iii. Calculate the power dissipated in resistor if resistance 'R' is 4Ω.

Q.6. To study variation of electric current with intensity of light using photoelectric
A schematic diagram is shown below to study the variation in electric current with the intensity of photocell. Data is recorded and mentioned in the table where "d" is the distance of a light source photocell and "I" is the current flowing in the circuit.



i. Copy and complete the table

No. of obs	Distance (d) (cm)	Current (I) (μA)	Intensity of (—)
1	60	15	
2	50	25	
3	40	55	
4	30	70	
5	20	115	
6	10	240	

ii. Plot the graph between current and intensity of light.

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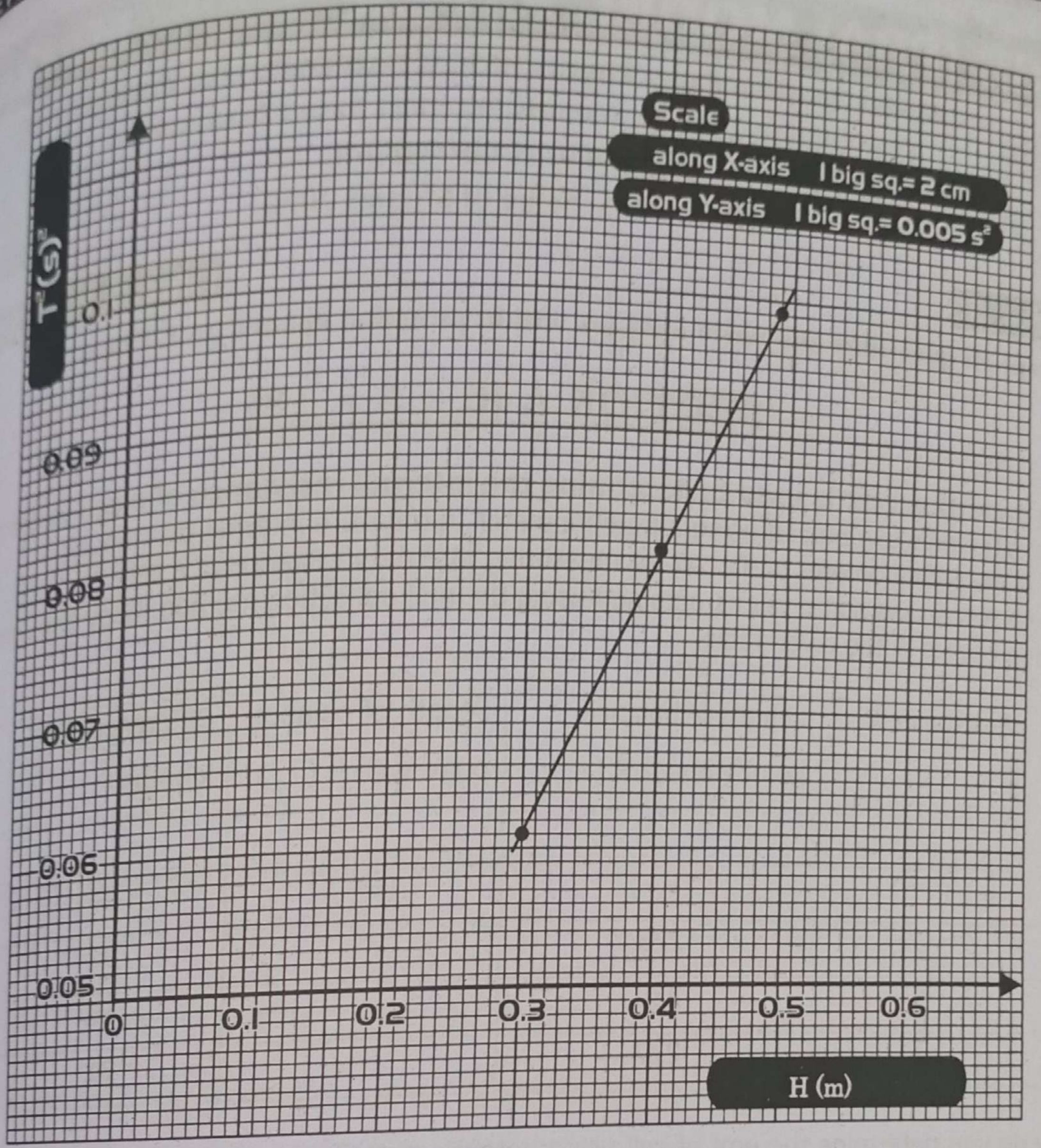
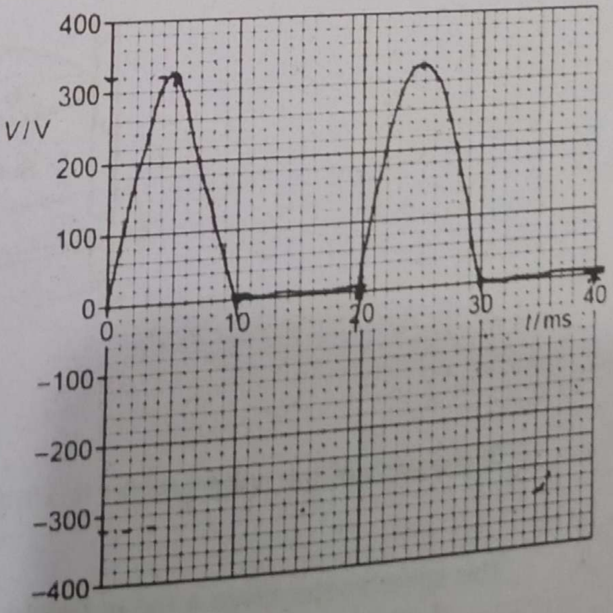


The equation of motion is $h = \frac{1}{2} g t^2$, so h is proportional to t^2, not t. A graph of h against t would give a curve, from which it is difficult to determine g accurately.

$$\omega = \frac{2\pi}{T}$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{100\pi} = 0.02s = 20 \times 10^{3} s = 20ms$$



The diode is reverse-biased during these half-cycles, which presents a very high resistance, preventing current from flowing through the circuit.

FBISE (PBA) MODEL PAPER

Marks 30

Model Question Paper Physics HSSC (COMPOSITE) For Annual
Examination 2026 & onwards Practical Based Assessment
(PBA) Physics Curriculum
(2022-23)-Scheme of Studies 2006

Time: 2 Hour 30 minutes

Total Marks: 30

Note: Attempt all questions and write answers within provided spaces on E-Sheet.

SECTION A (6 × 3 = 18)

Q.1. The potentiometer is used to determine the internal resistance of a cell in the lab.

i. What is the principle behind using a potentiometer to measure internal resistance? (0

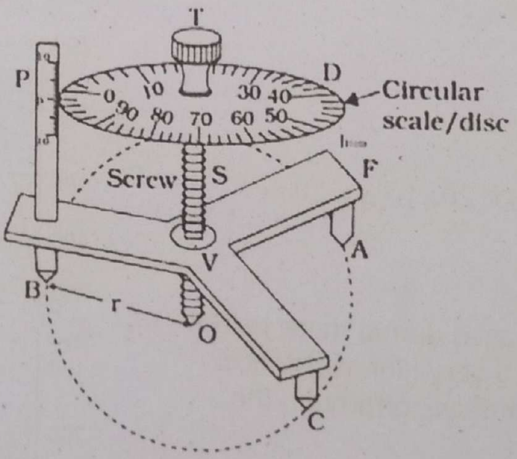
ii. Why is the potentiometer preferred for measuring internal resistance of a cell? (01

iii. Table below shows some values obtained using the null deflection method. Copy and complete the missing entries in the given table. (03)

No of obs	Resistance R	Length of balance point without R (ℓ_1)	Length of balance point with R (ℓ_2)	Difference of lengths	Internal resistance r
Unit	(----)	(----)	(----)	(----)	(----)
1	3	223		97	
2	5	236		56	
3	7	227		31	

iv. How do you determine the emf of cell using potentiometer? (01)

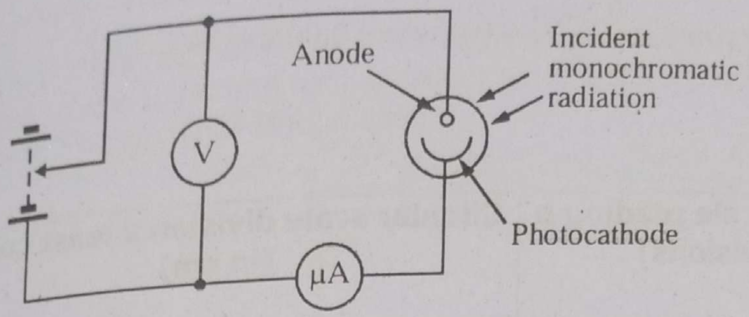
Q. 2. Figure shows a spherometer used to measure radius of curvature of a convex surface



i. If the pitch of the spherometer is 1 mm and there are 100 divisions on its disc, what its least count? (01)

ii. This spherometer gives a mean height of 2.42mm when placed on plane glass plate.

The diagram shows monochromatic light falling on a photocell. As the reverse potential difference between the anode and cathode is increased, the current measured by the micro ammeter decreases. when the potential difference reaches a value $V_{stopping}$, called the stopping potential, the current is zero.


Anode
Incident monochromatic radiation
Photocathode
V
μA

t be the effect on the stopping potential of
sing only the intensity of the incident radiation (01)

ng only the frequency of the incident radiation?

SOLUTION PRACTICE (PBA) MODEL PAPER-1 Marks 30

SECTION A

Q.1.

i.

$$Least\ count = \frac{0.5mm}{50} = 0.01mm = 0.001cm$$

ii. (a)

Main scale reading a	Circular scale reading b (divisions)	Circular scale division x least count (in cm)	Total reading = a (in cm)
2 mm	53	53x0.001cm=0.053	0.2+0.053=0.253

(b)

Height h of the spherical surface = Mean reading on spherical surface- Mean reading on plane glass pla

h =0.253 – 0.2 =0.053 cm

(c)

$$l = 3\,cm$$

$$R = \frac{l^2}{6h} + \frac{h}{2} = \frac{(3)^2}{6(0.053)} + \frac{(0.053)}{2} \approx 28.32\,cm$$

iii. For a convex surface, the reading on the spherical surface will be less than the reading on the p surface, resulting in a negative value of the sagitta. For a concave surface, the reading on the sp surface will be greater than the reading on the plane surface, resulting in a positive value of the sagitta.

Q.2.

i.

Units of $F = kg\,m\,s^{-2}$,Units of $r = m$, and units of $v = m\,s^{-1}$

Units of $\eta = \frac{kg\,m\,s^{-2}}{m \times m\,s^{-1}} = kg\,m^{-1}s^{-1}$

ii.

(a)

- One arrow vertically downwards labelled weight / W
- Arrows vertically upwards labelled U/ upthrust and drag / FD / viscous force

(b)

$$\eta = \left(\frac{2}{9}\right) g(\rho_s - \rho_f)\left(\frac{r^2}{v}\right)$$

$$\eta = \left(\frac{2}{9}\right)(9.81)(7850 - 870)\left[\frac{(1.4 \times 10^{-3})^2}{0.1}\right] = 0.3\,kg\,m^{-1}s^{-1}$$

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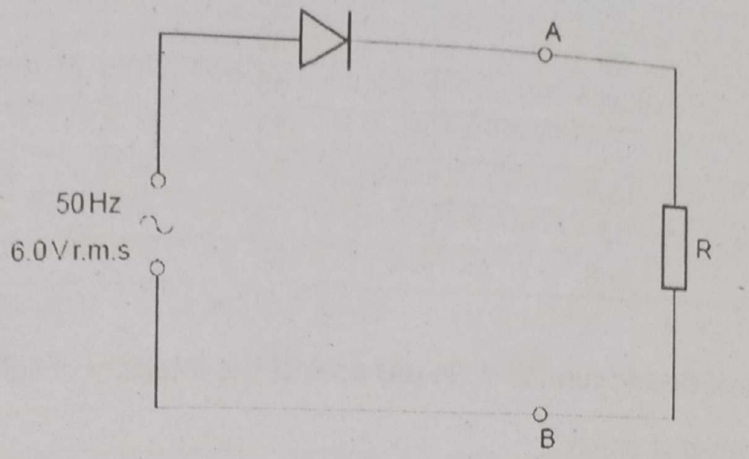
Q.5. A student sets up a half-wave rectifier circuit using a silicon diode. An alternating supply of frequency 50 Hz and having an output of 6.0 $V_{r.m.s.}$ is to be rectified so as to provide direct current for a resistor R. The circuit of Fig.I is used



The diode is ideal. The Y-plates of a cathode-ray oscilloscope (C.R.O.) are connected between points A and B.

Calculate the maximum potential difference across the diode during one cycle. [1]

Describe and explain the effect on the CRO trace if the diode is reversed in direction. [2]

Calculate the power dissipated in the resistor and state how it would change if the diode were reversed. [1]

Q.6. Two students, Abdullah and Hamza, are investigating the relationship between the electric curr generated by a photocell and the intensity of light. They alter the distance between the light source and photocell to change the intensity and record their results. Their goal is to evaluate the linearity of relationship and explore the theoretical implications of their observations.

(01)

i.

No. Of Obs.	Distance of Photocell from the bulb $d\,(cm)$	Photo electric Current $\theta\ (\mu A)$	Intensity of light $I=\dfrac{cons\tan t}{d^2}\left(cm^{-2}\right)$	$\dfrac{I}{\theta}\approx cons\tan t$
1	35	20	0.00082	
2	29	30	0.00119	
3	25	45	0.00160	
4	21	55	0.00227	
5	18.5	70	0.00292	
6	17	82	0.00346	
7	15.8	95	0.00400	

ii. Plot a graph of electric current θ (in μA) against the intensity of light $\dfrac{1}{d^2}$ using the provided data. And explain the trend of graph

(02

Suggest one modification to the setup to improve the accuracy of the viscosity determination, and your reasoning. (01)

3. In an experiment to determine the wavelength of sound in air using a resonance tube, students use forks of known frequencies and adjust the water level to find the first resonance positions for falling ing levels. They record the data in a table, aim to calculate the speed of sound at 0°C. The room ature is 20°C, and the end correction is e = 0.3d, where d is the tube diameter in cm.

The students obtain the following incomplete table for resonant lengths using a tube with d = 2.0 cm. Complete the table by calculating the mean resonant length L_1, the corrected length L, the wavelength λ, and the speed of sound v at room temperature for each frequency. (2)

uency f Hz	ℓ_1 (falling) cm	ℓ_2 (rising) cm	$L_1 = (\ell_1 + \ell_2)/2$ cm	$L = L_1 + e$ cm	$\lambda = 4L$ cm	$v = f\lambda$ cm s^{-1}
	32.4	32.6				
	25.8	26.0				
	21.4	21.6				

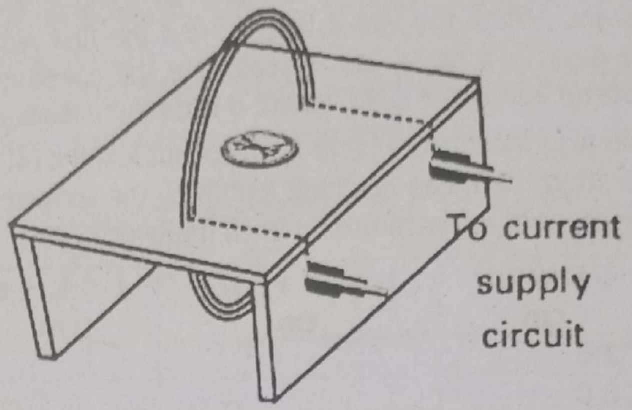
Explain how you would plot a graph of L against 1/f to determine the speed of sound v at room temperature. State the relationship and how v is obtained from the graph. (2)

Using the formula v = v0 + 0.6t, where t is the room temperature in °C, calculate v0, the speed of sound at 0°C, from the average v in the table. (1)

iv. Identify two significant sources of random error in determining the resonant length and suggest a practical way to minimize one of them. (1)

SECTION B (4 x 3 = 12)

Q.4. A student studies the magnetic field produced by a flat circular coil passing vertically on a board, compass is used to map the field on the axis of the coil and in the plane of the coil.



i. Sketch the magnetic field pattern for the coil in a plane containing the coil axis (show inside and outside (1)

ii. State the direction of the field on the coil axis when current flows clockwise as viewed from front. (1)

iii. Explain how field strength on axis changes with distance from the coil centre. (1)

iv. If the student uses 5 concentric turns instead of a single turn, how does the axial field at the centre change? Explain. (1)

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CTICE (PBA) MODEL PAPER-1

Marks 30

Model Question Paper Physics HSSC (COMPOSITE) For Annual Examination 2026 & onwards Practical Based Assessment (PBA) Physics Curriculum (2022-23)-Scheme of Studies 2006

Time: 2 Hour 30 minutes

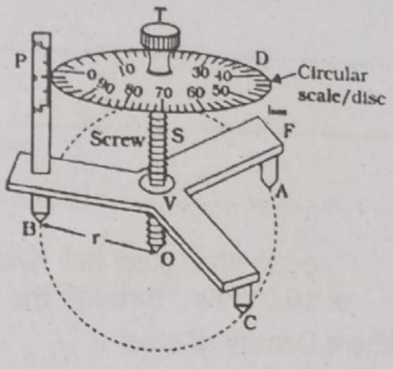
ks: 30

pt all questions and write answers within provided spaces on E-Sheet.

SECTION A (6 × 3 = 18)

dents use a spherometer to measure the radius of curvature of a convex lens.

e pitch of the spherometer is 0.5 mm and there are 50 divisions s disc, what is its least count? (01)



s spherometer gives a mean height of 2 mm when placed on a plane glass plate. Now it is placed on convex surface of the lens. The distance between any two outer legs is 3 cm. d complete the table. (02)

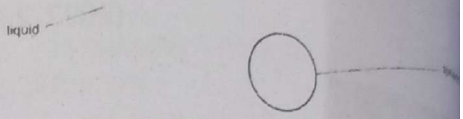
	Circular scale reading b (divisions)	Circular scale division x least count (in cm)	Total reading = a + b (in cm)
	53		

e the height of the spherical surface. (01)

e the side length of the equilateral triangle formed by the legs of the spherometer and use it to radius of curvature. (01)

would you differentiate between convex and concave surfaces using a spherometer? (01)

Q.2. Motor-oil companies rate engine oils by their "kinematic viscosity"
In an experiment, students drop spherical steel ball into a column of engine oil and use timing gates to record the time taken to fall a fixed distance after reaching terminal velocity. The goal is to calculate the viscosity of the oil.



i. Show that the SI base units of viscosity are $kg\,m^{-1}\,s^{-1}$. (01)

ii. The spherical steel ball has a radius of 1.4 mm and is falling vertically downwards at a terminal velo of 10.0 cm s^{-1} through the fluid.

Where Density of steel $= \rho_{steel} = 7850\,kg\,m^{-3}$ and Density of Motor-oil $= \rho_{motor\,oil} = 870\,kg\,m^{-3}$

(a) The sphere is shown in Fig. Draw and label arrows to represent the directions of the three forces acting on the sphere as it falls at terminal velocity through the liquid. (01)

(b) Calculate the viscosity of the liquid. (02)

iii. The student repeats the measurement with a second ball of the same diameter but half the mass. Explain whether the new terminal speed will be greater, smaller or the same. (01)

iii.

New terminal speed will be smaller.
Explanation:
At terminal velocity drag = weight
Smaller weight → smaller drag needed → smaller v

iv.

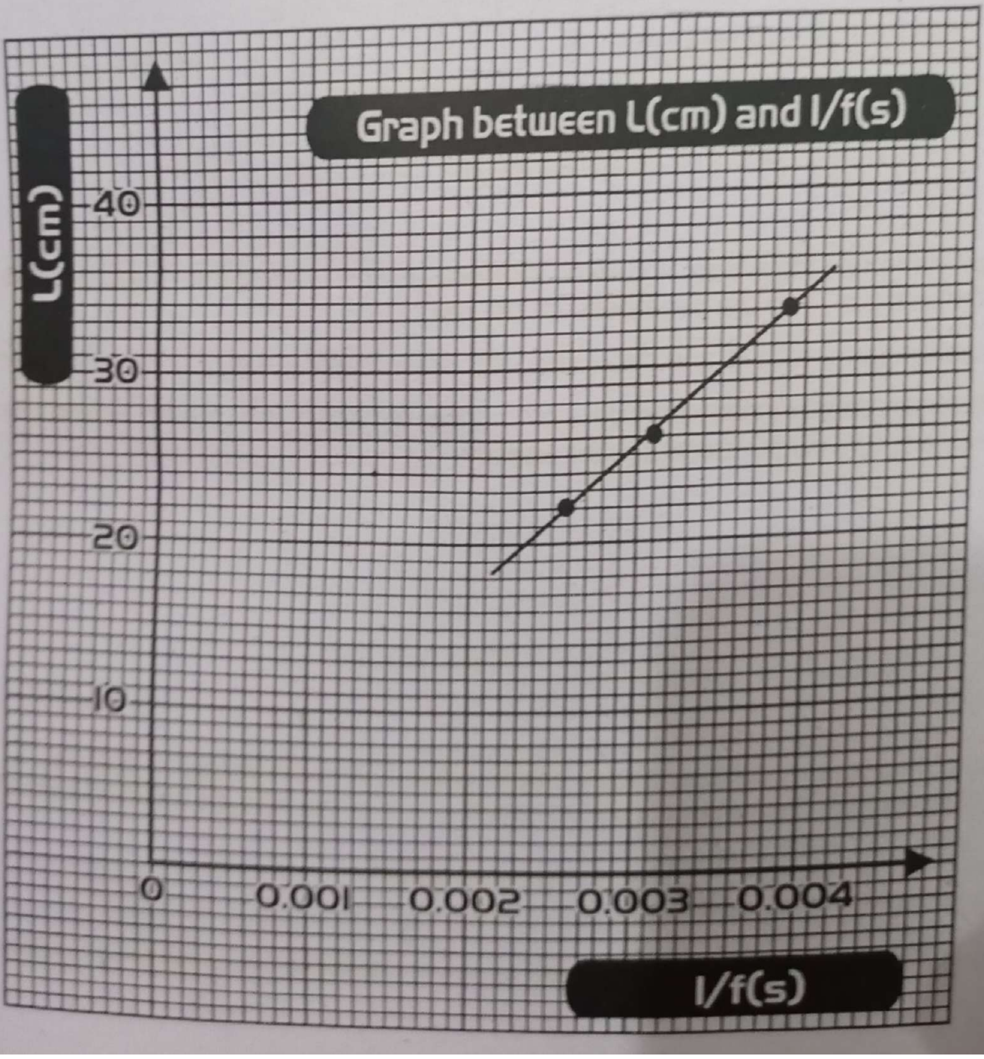
a. Use a longer column to ensure terminal velocity is reached earlier/reduce entry effects.
b. Control temperature as viscosity varies with it.

Q.3.

(i)

Frequency f Hz	l_1 (falling) cm	l_2 (rising) cm	$L_1 = (l_1 + l_2)/2$ cm	$L = L_1 + e$ cm	$\lambda = 4L$ cm	$v = f\lambda$ cm s^{-1}
256	32.4	32.6	35.5	33.1	132.4	33894.4
320	25.8	26.0	25.9	26.5	106	33920
384	21.4	21.6	21.5	22.1	88.4	33945.6

(ii)



iii.

$$v_{av} = \frac{33894.4 + 33920 + 33945.6}{3} = 33920\,cm\,s^{-1}$$

$$v = v_0 + 0.6t$$

$$v_0 = v - 0.6t = 33920\,cm\,s^{-1} - 0.6(20) = 33908$$

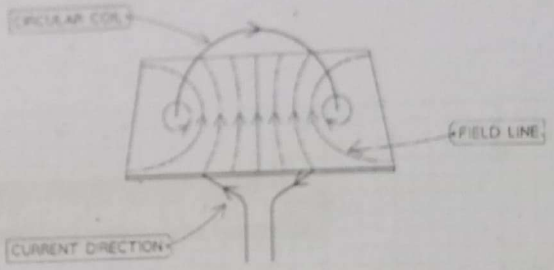
iv. Make sure the marker is a thin line to get a more accurate reading of the water level
Submerge the tube into the water slowly, so the antinode of the sound wave (loudest sound)
missed

Q.4.

i. Inside (through centre) field lines are approximately straight and perpendicular to the plane of the
pointing along the axis

Outside lines curve away and close back around the coil, forming loops.

Indication that field is strongest near centre and weakens away



ii. Use right-hand rule for a loop: if current is clockwise when viewed from front, the field points down along the axis (i.e., into the page beneath the coil).

iii. Field is maximum at centre and decreases with distance along axis.

iv. Field at centre approximately multiplies by number of turns N (i.e., 5 turns → field ≈5× single-tu because each turn adds its contribution linearly.

Q 5

i. $V_{rms} = \frac{V_{peak}}{\sqrt{2}}$

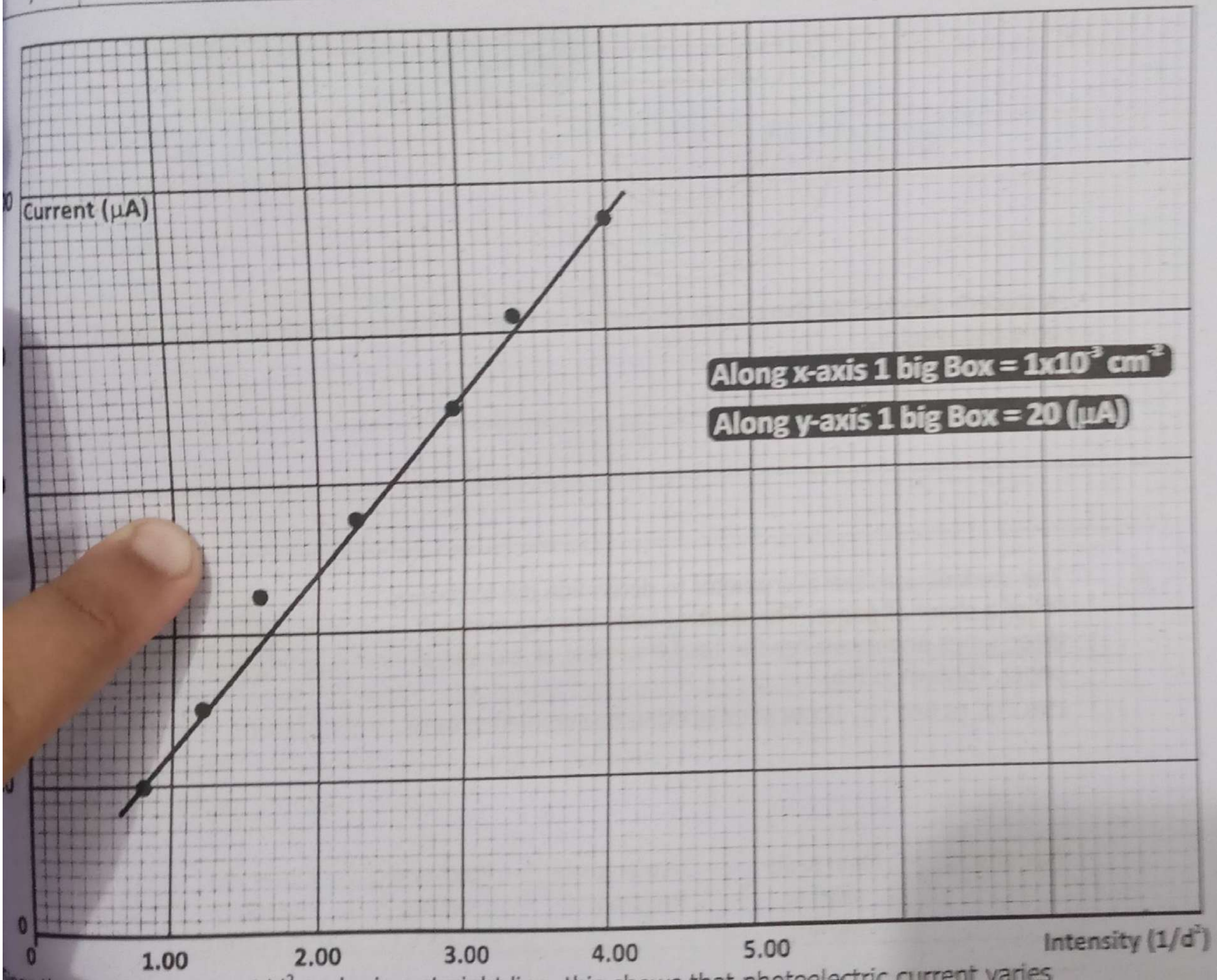
$$V_{peak} = \sqrt{2}V_{rms} = \sqrt{2}(6V) = 8.48V$$

ii. Output waveform shifts to display only negative half-cycles instead of positive
Because diode now conducts during negative half of the AC cycle and blocks positive

$$P = \frac{V_{rms}^2}{R} = \frac{(6V)^2}{1000\Omega} = 36\times10^{-3}W = 36\,mW$$

iii. If diode is reversed, same magnitude of power dissipated since only phase inverted

No. Of Obs.	Distance of Photocell from the bulb $d\,(cm)$	Photo electric Current θ (μA)	Intensity of light $I=\frac{constant}{d^2}\,(cm^{-2})$	$\frac{I}{\theta}\approx constant$
1	35	20	0.00082	4.10×10^{-5}
2	29	30	0.00119	3.96×10^{-5}
3	25	45	0.00160	3.55×10^{-5}
4	21	55	0.00227	4.12×10^{-5}
5	18.5	70	0.00292	4.17×10^{-5}
6	17	82	0.00346	4.21×10^{-5}
7	15.8	95	0.00400	4.21×10^{-5}



nce the graph between $1/d^2$ and q is a straight line, this shows that photoelectric current varies irectly to the intensity of incident light.

(a) When increasing only the intensity of the incident radiation, there is no effect on results

(b) When increasing only the frequency of the incident radiation, there is increases stopping potential

PRACTICE (PBA) MODEL PAPER-2

Model Question Paper Physics HSSC (COMPOSITE) For Annual
Examination 2026 & onwards Practical Based Assessment
(PBA) Physics Curriculum
(2022-23)-Scheme of Studies 2006

Total Marks: 30

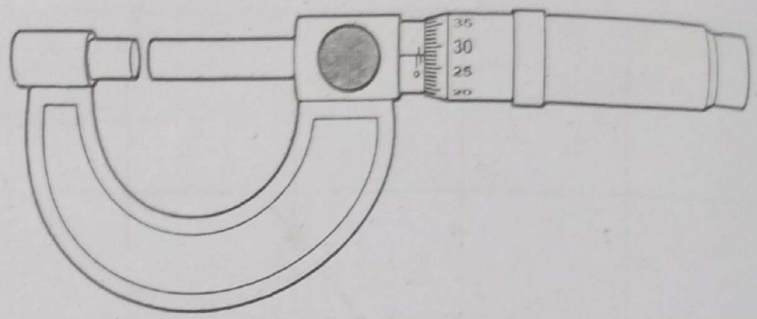
Time: 2 Hour

Note: Attempt all questions and write answers within provided spaces on E-Sheet.

SECTION A (6 × 3 = 18)

Q.1.

Fig. shows a micrometer screw gauge.



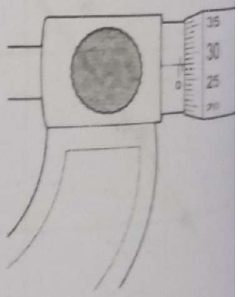
i. A student checks that there is no zero error on this micrometer. Explain what is meant by on a micrometer.

____

____

____

ii. The student uses the micrometer to determine the thickness "t" of a sheet of paper. The student folds the paper in half three times and measures the total thickness of the folded paper. (Shown in Fig)
Use Fig. to find "t". Show your working by completing table. (2)



No. of obs.	Main scale reading M(mm)	Circular scale Reading 'n'	Fractional reading V= n x L.C.	Observed Reading t=M+C(mm)

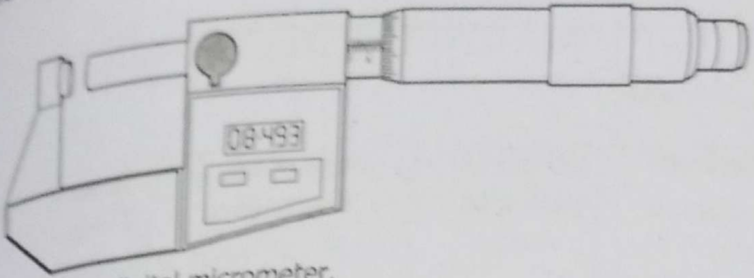
iii. Mention the uncertainty in result using Screw Gauge experiment.

____

____

____

micrometers are digital available in market.

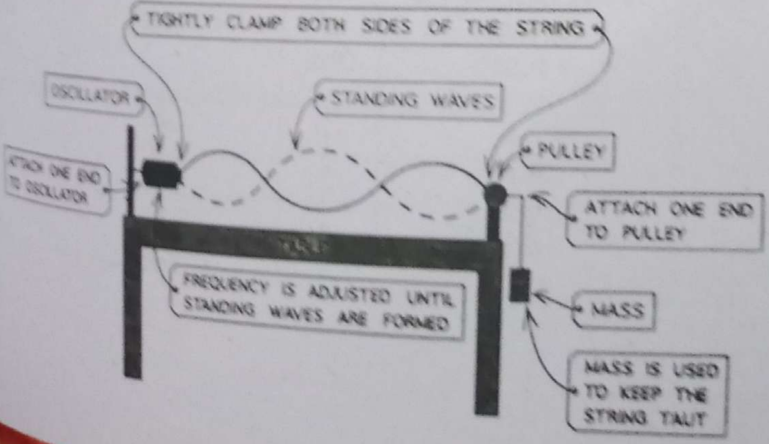


advantage of a digital micrometer. (1)

asure the diameter of your hair by your screw gauge? (1)

Melde's experiment to investigate stationary waves on a steel strip connected to a thread, magnet driven by an AC supply. The thread's mass is 0.80 g over 250 cm, with a pan mass of is varied by adding weights, and $g = 981\ cm/s^2$. The table records the number of loops (n), extreme nodes (L), and total mass on the pan (M).

ength, m, of the thread in $g\,cm^{-1}$.


TIGHTLY CLAMP BOTH SIDES OF THE STRING
OSCILLATOR
STANDING WAVES
ATTACH ONE END TO OSCILLATOR
PULLEY
ATTACH ONE END TO PULLEY
FREQUENCY IS ADJUSTED UNTIL STANDING WAVES ARE FORMED
MASS
MASS IS USED TO KEEP THE STRING TAUT

(i) Determine the mass per unit length

(ii) Fill in the missing values in the table.

No. of obs.	No. of loops (n)	Distance between extreme nodes L (cm)	Length of each loop (cm)	mass of pan + mass added $M = m_1 + m_2$ (g)	Tension T=Mg (dynes)	Frequency of vibrating (Hz)
1	4	50		35		
2	4	60		45		
3	4	70		60		

Mean value : ______________________

iii. Source frequency: ______________________

iv . What factors affect the wave velocity on the wire? How does it impact the experiment?

Q .3.

Students are investigating the charging and discharging behavior of a capacitor through a 10Ω resis the capacitor initially uncharged and connected to a 10V DC source.

For charging			**For discharging**		
No. of Obs.	Time t (sec)	Voltage across the capacitor V (volt)	No. of Obs.	Time t (sec)	Voltage across th capacitor V (volt)
1.	1.50	2.3	1	1.20	8.2
2.	3.20	4.7	2	3.00	6.1
3.	5.10	6.3	3	5.50	4.5
4.	7.40	8.1	4	8.00	2.7
5.	10.0	9	5	12.00	0.8

Plot the graph of voltage V across the capacitor versus time t for the discharging process. (02)

(01)

Calculate time constant from graph.

Describe how the time constant τ would change if the resistance R were increased to 20Ω. (01)

State and explain the trend in the power dissipated across the resistor R during the discharging process. (02)

SECTION B (4 × 3 = 12 Marks)

Q.4. A vertical spring system is used to study elastic potential energy. A student observes that spring is stretched by applying forces. The data collected is shown below.
A light spring of unextended length 14.2cm is suspended vertically from a fixed as illustrated in Fig. 1.

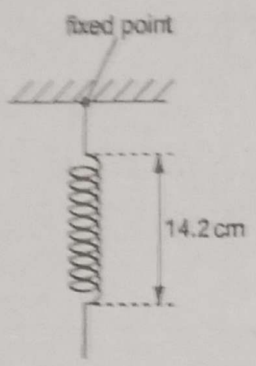


Fig. 1

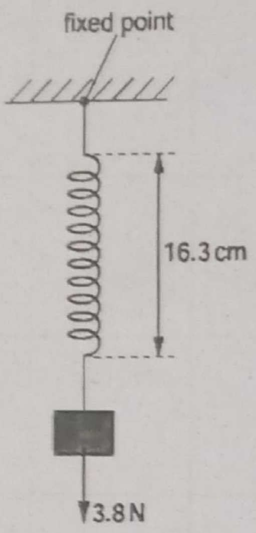


Fig. 2

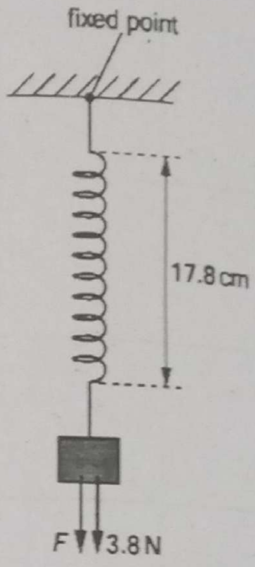


Fig. 3

A mass of weight 3.8N is hung from the end of the spring, as shown in Fig. 2. The length of the spring is now 16.3cm.
An additional force F then extends the spring so that its length becomes 17.8cm, as shown in Fig. 3.
The spring obeys Hooke's law and the elastic limit of the spring is not exceeded.

(i) Show that the spring constant of the spring is $1.8\,Ncm^{-1}$. (1)

(ii) Show that the change in elastic potential energy of the spring is 0.077J. (2)

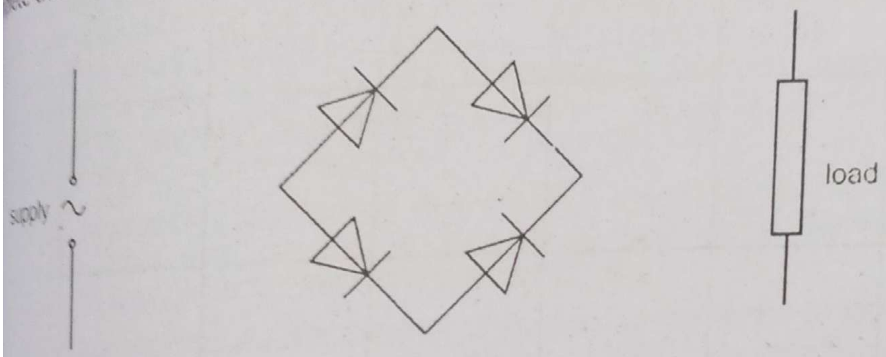
CS CamScanner

raph of load against extension is plotted, explain why it should pass through the origin and what
icates about the spring's behavior. (1)

estigates full-wave rectification using a bridge rectifier (four diodes) and a AC source connected
e input and output waveforms are displayed on a CRO for analysis.

omponents for a bridge rectifier are shown in Fig

ete the circuit of Fig. by showing the connections of the supply and of the load to the diodes. (2)



udent measures the peak voltage of the output waveform to be 7.1 V. Calculate the RMS voltage
s the load resistor. (1)

est one modification to obtain a smoother DC output and explain how it works. (1)

Q.6. **A student investigates the acceleration due to gravity by releasing a steel ball held by an electromagnet. When the electromagnet is switched off, the ball falls vertically through a known height h, and an electronic timer records the fall time t. The procedure is repeated for different heights.**

i. Complete the table by calculating the missing value of g? (1)

Sr. No.	Height (h) m	Time (t) s	g=?
1	0.300	0.248	
2	0.400	0.286	
3	0.490	0.316	

ii. Plot a graph of h (x-axis) and T^2 (y-axis). (2)

iii. The students plan to plot a graph of h against t. Explain why this is not a suitable graph for determining g and state what they should plot instead. (1)

SOLUTION PRACTICE (PBA) MODEL PAPER-1 Marks 30

SECTION A

If the reading on a micrometer is not zero when it is completely closed (with out an object), then the reading shown it is known as the zero error on micrometer

No. of obs.	Main scale reading M(mm)	Circular scale Reading 'n'	Fractional reading V= n x L.C.	Observed Reading t=M+C(mm)
1	1.0 mm	28	28 x 0.01 mm	1.0 mm + (28 x 0.01 mm) = 1.28 mm

Therefore, the single sheet thickness $\frac{total\ thikness\ of\ folded\ paper}{no.of\ sheet\ in\ folded\ paper} = \frac{128mm}{8} = 0.16\,mm$

The uncertainty in a screw gauge result depends on two factors:

Least count: This is the smallest difference the instrument can measure, typically 0.01 mm or 0.001 mm. It represents the minimum possible uncertainty in your result.

Random errors: These are small, unpredictable variations in your readings due to factors like temperature, vibration, or parallax error. They're difficult to quantify but can be minimized by taking multiple readings and averaging them.

Digital micrometers can typically measure to a higher degree of precision, often resolving readings down to 0.001 mm compared to 0.01 mm on most analog models. This significantly reduces the margin of error, especially for critical measurements.

No, we cannot measure the diameter of our hair by this screw gauge because the diameter of hair is less than the least count of screw gauge.

$$m = \frac{mass}{lenght} = \frac{0.80g}{250cm} = 0.0032\,g\,cm^{-1}$$

No. of loops (n)	Distance between extreme nodes L (cm)	Length of each loop $\ell = \frac{L}{n}$ (cm)	mass of pan + mass added $M = m_1 + m_2$ (g)	Tension T=Mg (dynes)	Frequency of vibrating segment $f = \frac{1}{2L}\sqrt{\frac{T}{m}}$ (Hz)
4	50	12.5	35	34335	$f = \frac{1}{2(12.5)}\sqrt{\frac{34335}{0.0032}} = 98.4Hz$
4	60	15.0	45	44145	$f = \frac{1}{2(15)}\sqrt{\frac{44145}{0.0032}} = 100.2Hz$
4	70	17.5	60	58860	$f = \frac{1}{2(17.5)}\sqrt{\frac{58860}{0.0032}} = 101.2Hz$

CS CamScanner

Mean value $= 99.9Hz$

iii. $f_{string} = 2f_{source}$

$$f_{source} = \frac{f_{string}}{2} = \frac{99.9Hz}{2} \approx 50Hz$$

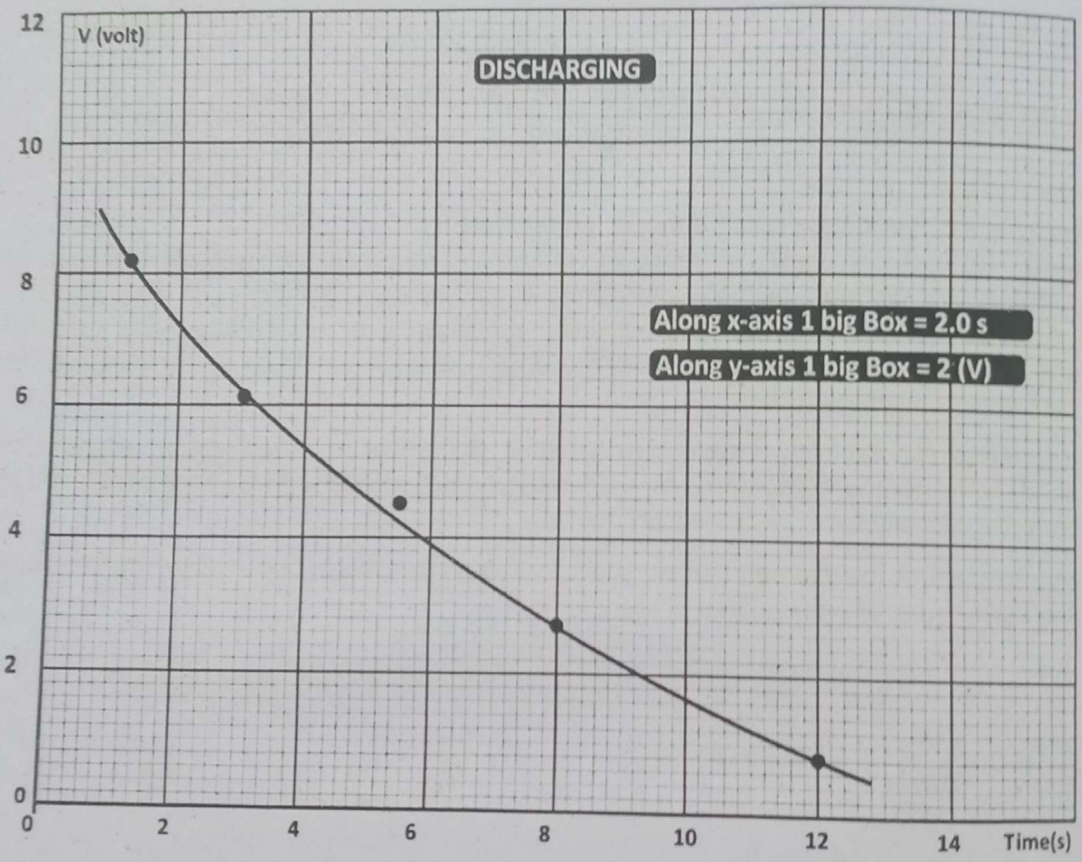
iv.

Wire stiffness: Stiffer ropes make waves travel faster, changing the rope length needed for resonance.

Tension: Tightening the rope makes waves go faster, again affecting the position for resonance

Q.3.

i.



ii. The time constant $\tau = RC$ is found by locating the time when the voltage reaches 63% of its final value for charging or falls to 37% for discharging. From the graphs, estimated value is $\tau \approx 3.2s$.

iii. Increasing R to 20Ω increases τ, leading to slower charging/discharging

iv. The power dissipated decreases (from a maximum to zero).

Explanation: $P_{dissipated} = \frac{V^2}{R}$

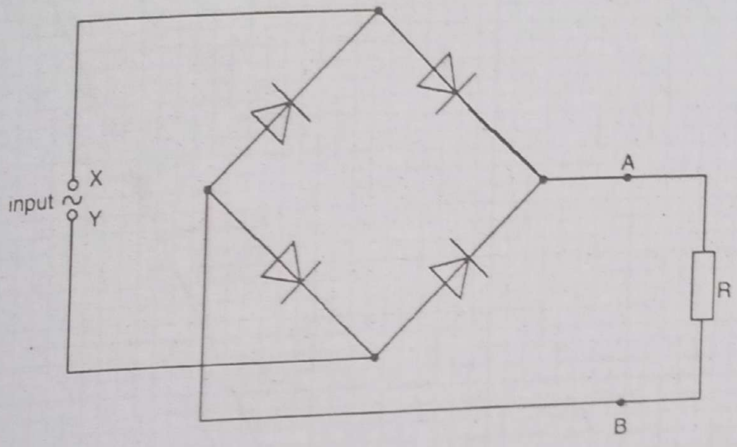
As the capacitor discharges, the voltage V across the resistor and capacitor decreases exponentially with time. Since P is proportional to V^2, the power decreases exponentially.

SECTION B

$$k=\frac{F}{\Delta x}=\frac{3.8\,N}{16.3cm-14.2\,cm}=\frac{3.8\,N}{2.1\,cm}=1.8\,Ncm^{-1}$$

$$E=\frac{1}{2}F\Delta x=\frac{1}{2}\left(1.8\times10^{2}\,Nm^{-1}\right)\left[(0.036m)^{2}-(0.021m)^{2}\right]=0.077J$$

The graph passes through the origin because there is no extension when no load is applied, this indicates the spring obeys Hooke's law (proportional relationship) with no permanent deformation.



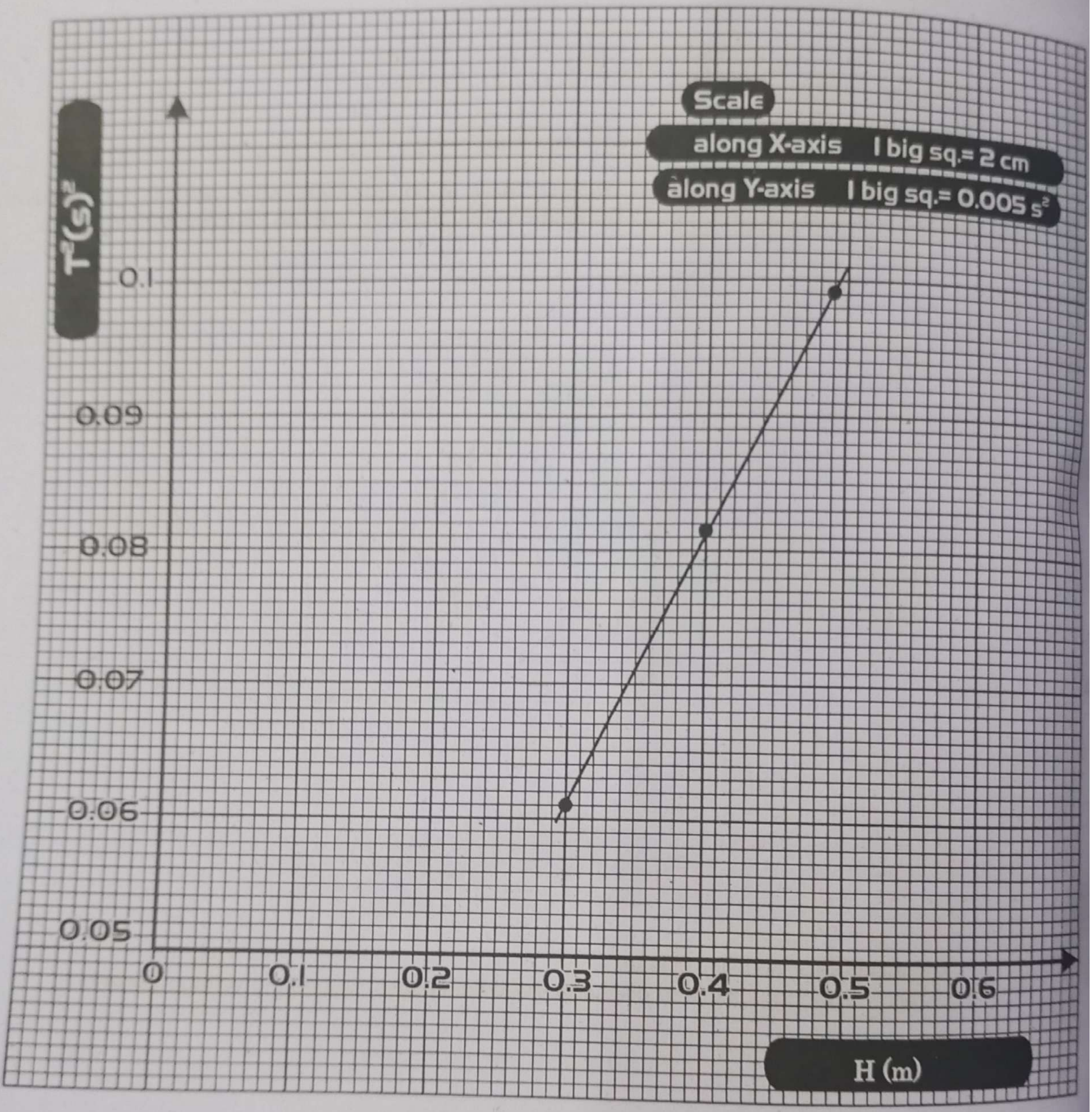
$$V_{rms}=\frac{V_{o}}{\sqrt{2}}=\frac{7.1V}{\sqrt{2}}=5.02V$$

Add a capacitor across the load

It charges during peaks and discharges between peaks, smoothing voltage variations.

Sr. No.	Height (h) m	Time (t) s	$g=\frac{2h}{t^2}$ (ms^{-2})
1	0.300	0.248	9.76
2	0.400	0.286	9.78
3	0.490	0.316	9.81

ii.



iii. The equation of motion is h = ½ g t², so h is proportional to t², not t. A graph of h against t would give a curve, from which it is difficult to determine g accurately.